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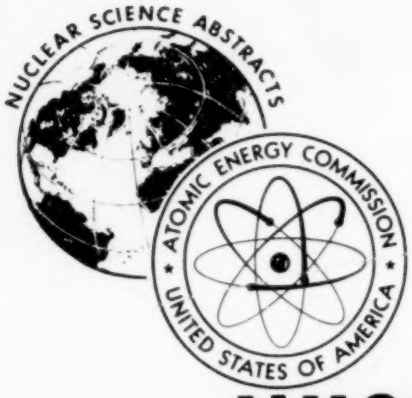

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Volume 16 Number 6A
Abstracts 6253–7337

March 31, 1962

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Volume 16, Number 6A March 31, 1962

NUCLEAR SCIENCE ABSTRACTS

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Use of funds for printing this publication has been approved by the Bureau of the Budget, July 29, 1960.

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NUCLEAR SCIENCE ABSTRACTS

GENERAL AND MISCELLANEOUS

6253 (ARGMA-TN-2H1N-30) RESEARCH LABORATORY QUARTERLY RESEARCH REVIEW NO. 30, MAY 1, 1961–JULY 31, 1961. (Army Rocket and Guided Missile Agency, Redstone Arsenal, Ala.). Nov. 1, 1961. 81p.

Supporting research activities of the Research Laboratory, Research and Development Operations, during the period May 1, 1961 through July 31, 1961 are described. Experimental results and development information are included on materials, nuclear physics, fuels and combustion, physical electronics, high-temperature physics, and solid-state physics. (auth)

6254 (NP-11230) THE AIMS AND ORGANISATION OF THE AUSTRALIAN ATOMIC ENERGY RESEARCH ESTABLISHMENT. K. F. Alder and J. L. Symonds (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Aug. 1961. 14p.

An outline of the development of the AAEC Research Establishment at Lucas Heights, N. S. W., is presented together with a brief description of the supporting facilities available for the research program. Some of the principal features of the organization of the Establishment are described and some space is devoted to the aims of the reactor research program. (auth)

6255 (ONR-9(Vol.2)) NAVAL RESEARCH FIFTH NAVY SCIENCE SYMPOSIUM, APRIL 18, 19, 20, 1961, U. S. NAVAL ACADEMY, ANNAPOLIS, MARYLAND. (Office of Naval Research, Washington, D. C.). 410p. (AD-260240)

Twenty-nine papers are included which cover a wide variety of subjects in science (chemistry, physics, engineering) and sociological problems in the Navy. Separate abstracts were prepared for three of the papers; one was previously abstracted in NSA. (D.L.C.)

6256 (ONR-9(Vol.2)(p.420-32)) INCIDENT DOSE AND TISSUE DOSE IN PROTON RADIATION FIELDS IN SPACE. Hermann J. Schaefer (Naval School of Aviation Medicine, Pensacola, Fla.).

Some problems of space radiation fields which confront the radiobiologist are described. The energy spectra of the space proton beams always show a steep negative slope limited at the low-energy side by a cut-off, and thus the dose distribution within a tissue target will drop off sharply with depth. The relative merits of differential energy spectrum and differential range spectrum plots are discussed with respect to shielding effects. Depth dose curves were computed for two spherical tissue phantoms of diameters 30 and 4 cm and representing the human body and a small test animal, respectively. The results indicate that a different radiation field, e.g., flare-produced radiation, may have to be used with small test animals to establish permissible dose levels for man in one radiation field, e.g., Van Allen radiation. Difficulties involved in the use of LTE, RBE, and integral dose are discussed, and the extent of knowledge of the flare-produced radiations is summarized. (D.L.C.)

6257 (ONR-9(Vol.2)(p.433-52)) THERMOELECTRIC AND THERMIONIC ENERGY CONVERSION. Paul H. Egli (Naval Research Lab., Washington, D. C.) and J. J. Connelly (Office of Naval Research, Washington, D. C.).

The development of thermoelectric materials is summarized, and properties are described for the following materials: Bi_2Te_3, PbTe, ZnSb, GeTe, III-V compounds, MnTe, and CeS. Feasible thermoelectric applications are outlined, and the problems involved are discussed. Research being conducted by various companies in the field of thermionic energy conversion is described. (D.L.C.)

6258 (ONR-9(Vol.2)(p.554-66)) THE JET-ARC IMAGE FURNACE AS A HIGH-TEMPERATURE RESEARCH TOOL. J. A. Carter, J. Dennis, A. Lawes, F. DeBold, W. Derksen, and T. I. Monahan (New York Naval Shipyard. Material Lab., Brooklyn).

Information is presented on the jet-arc double-ellipsoid imaging furnace and its operating characteristics, e.g., irradiances, obtainable image sizes, flux distributions, and attainable sample temperatures. Results of some investigations made with this unit are described, and the types of measurements which can be made with this unit are given. (D.L.C.)

6259 (TID-3561(Rev.1)) DIRECT ENERGY CONVERSION DEVICES. A Literature Search. Henry D. Raleigh, comp. (Division of Technical Information Extension, AEC). Jan. 1962. 37p.

Unclassified references (344) to information on nuclear batteries, thermoelectric cells, thermionic cells, and the SNAP program are given. (N.W.R.)

6260 (UCRL-6438(Pts.I and II)) PROCEEDINGS OF THE GEOPHYSICAL LABORATORY LAWRENCE RADIATION LABORATORY CRATERING SYMPOSIUM, WASHINGTON, D. C., MARCH 28-29, 1961. Milo D. Nordyke, ed. (California. Univ., Livermore. Lawrence Radiation Lab.). Oct. 1961. Contract W-7405-Eng-48. 475p.

Proceedings of a symposium attended by scientists who are interested in explosion craters and those interested in terrestrial and lunar meteor craters are reported. Included are papers containing information and data on meteor and

explosion craters, cratering theory, and throw-out calculations. (J.R.D.)

6261 (UCRL-13029) A STUDY OF SOME CRATERING CRITERIA FOR PROJECT CHARIOT. Final Report. L. M. Swift (Stanford Research Inst., Menlo Park, Calif.). Jan. 31, 1961. For Univ. of California Lawrence Radiation Lab., Livermore. Contract [W-7405-Eng-48]. Subcontract 122. 44p.

A study of explosive cratering data applicable to predictions useful to Project Chariot showed that the major indeterminate factor in such predictions is the translation from HE to nuclear explosives when the shot is to be in a nearly dry, non-calcareous medium. It is shown that the major cratering mechanism for large explosions is venting and scouring by gases and vapors, and that the vapors produced under the proposed Chariot conditions may not remain in gaseous form long enough to be fully effective. Small-scale simulation of nuclear cratering charges does not appear feasible; therefore a preliminary nuclear test in a hard dry rock is recommended. (auth)

6262 (XDC-60-4-61) SOVIET SCIENTIFIC AND TECHNICAL LITERATURE. Selected Bibliography, Volume II. (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). [nd]. Contract AT(11-1)-171. 277p.

The bibliography includes references on aircraft design, aircraft nuclear propulsion, apparatus and testing methods, automatic and remote control, gas turbines, high temperature materials, heat transfer, hoisting equipment, manufacturing technology, nuclear fuel, nuclear radiation environment, pumps, and tires. About 3500 references. (J.R.D.)

6263 SOME ACTUAL APPLICATIONS OF PLASMA JETS. M. Foex. Nucleus (Paris), No. 4, 230-44(July-Aug. 1961). (In French)

Plasma jet stabilization with water, gas, and magnetic fields is first considered. A small laboratory jet is described, and the general characteristics of commercial apparatus are reviewed. The practical applications of the plasma jet discussed are: cladding refractory materials, cutting refractory materials, high temperature chemical synthesis, space flight, high temperature physics studies, and radiant source for mirror furnaces. The methods used for the measurement of the temperature of plasma jets are reviewed briefly. (J.S.R.)

6264 MOTION OF THE FREE SURFACE OF A HOMOGENEOUS TERRAIN DURING AN UNDERGROUND EXPLOSION. N. I. Onis'ko and E. I. Shemyakin. Zhur. Priklad. Mekh. i. Tekh. Fiz., No. 4, 82-93(July-Aug. 1961). (In Russian)

The question of the propagation of seismic waves in a semi-infinite elastic medium is examined where these waves are produced by a non-stationary spherically symmetric source. This problem is posed in connection with the investigation of wave processes taking place in the ground and caused by underground explosions. The study is basically oriented to the construction of theoretical oscillograms of the motion of points of the free surface of the medium. It was thus calculated that the source of the waves can be described by a function, chosen on the basis of experimental data from explosions. (TTT)

6265 BASIC PRINCIPLES OF THE TRACER METHOD. Introduction to Mathematical Tracer Kinetics. C. W. Sheppard. New York, John Wiley & Sons, Inc., 1962. 295p.

The basic principles of tracer techniques are given in order that one may know what may or may not be done with the results of experiments in order to obtain meaningful information. The information given does not tell how to perform a tracer experiment. The results that may be expected to occur in a kinetic system following the introduction of labeled material into a portion of the system are discussed. The material indicates the easily and difficultly accomplished tracer experiments. Current methods of applied mathematics, including numerical analysis with digital computers and analog simulation procedures, are taken into consideration; and there is a clear indication of how applications may be made in the field of chemistry, physics, and physiology. (N.W.R.)

6266 THE JOINT RESEARCH AND DEVELOPMENT PROGRAM QUARTERLY DIGEST, PERIOD FROM 1 JANUARY TO 31 MARCH 1961. Vol. 1, No. 2. (United States-Euratom Joint Research and Development Program). 45p. $5.00 per yr. (Euratom).

The contracts entered into force before March 31, 1961, are listed, and the scope of programs contracted during the report period is outlined. Technical progress of various projects during the report period is described. A list of progress reports is included. (D.L.C.)

BIOLOGY AND MEDICINE

General and Miscellaneous

6267 (NP-11258) INVESTIGATION TO DETERMINE THE MECHANISM FOR PRODUCTION OF THE HEMORRHAGIC SYNDROME WHICH DEVELOPS IN MALE RATS THAT RECEIVE DIETS CONTAINING IRRADIATED BEEF. Final Report. L. R. Richardson (Texas. Agricultural Experiment Station, College Station). Sept. 1961. Contract DA-49-007-MD-582. 20p.

Studies were carried out to determine the mechanism for the production of the hemorrhagic syndrome which develops in male rats receiving irradiated beef. Whole irradiated and nonirradiated beef and irradiated and nonirradiated soybean protein were used as starting materials in this study. The incidence and severity of the hemorrhagic syndrome was more severe in male rats from the Holtzman strain than in those from the Texas A. & M. Colony. Hemorrhages developed in male rats receiving nonirradiated soybean protein and ether-alcohol extracted dried nonirradiated beef. Therefore, it is concluded that the irradiation process per se was not responsible for the irradiated beef producing the syndrome. The incidence of hemorrhages was consistently higher in male rats receiving 40 percent dietary protein than those receiving 12 or 20% dietary protein. Vitamin K (Menadione) prevented the hemorrhages. Supplementing the 12 and 40% dietary protein diets with different amounts of menadione showed that larger amounts of Vitamin K were required to prevent the hemorrhages when the diet contained 40% irradiated protein than when it contained 12%. The same trend was obtained in preliminary tests with nonirradiated protein and it is tentatively concluded that high protein diets increase the Vitamin K requirement of male rats. Two amino acid mixtures decreased the incidence of the hemorrhagic syndrome. One contained 14 pure amino acids. The other mixture contained three of the amino acids present in mixture I. These were L glutamic acid, L cystine and glycine. Addition of 2.0% of DL methionine reduced the incidence of the syndrome when the diet contained irradiated soybean protein, but it had comparatively little effect when the diet contained nonirradiated or control soybean protein. Further studies are needed to confirm the action of amino acids in preventing or reducing the incidence of the hemorrhages and to determine the mechanism of their action. The incidence of hemorrhages was higher in rats receiving 60,000 IU of Vitamin A/kg than in those receiving 30,000 IU. A higher incidence of hemorrhages occurred in the offspring when the diet of the mother was low in both Vitamin K and Vitamin A. (auth)

6268 (NP-11261) HEMORRHAGIC SYNDROME IN RATS FED IRRADIATED BEEF. Final Report, September 1, 1958 to July 15, 1961. E. A. Doisy, Jr. and J. T. Matschiner (Saint Louis Univ. School of Medicine). Contract DA-49-007-MD-996. 10p.

Results are summarized from a study of mechanisms involved in the induction of the hemorrhagic syndrome in rats fed irradiated beef. It was found that the addition of vitamin A is necessary to produce low prothrombins. The standard beef diet of Metta and Johnson lowers rat prothrombin if as little as 0.5 i.u. of vitamin A is added per gm of diet, while serious depression occurs if 5 or 50 i.u./gm are added. Other studies showed that casein has a protective effect while cold alcohol extraction makes casein and soy protein more hemorrhagenic. Certain lipids were found to lower prothrombin, notably squalene, while oxidation of soy oil and squalene renders them much more hypoprothrombinogenic. The most hemorrhagenic substance yet studied was found to be vitamin A acid. Its effects were 10 to 50 times more severe than vitamin A acetate in lowering prothrombin. The induced hypoprothrombinemia could be reversed or prevented by the addition of small amounts of vitamin K. (auth)

6269 (NP-11282) THE GROWTH, BREEDING, LONGEVITY AND HISTOPATHOLOGY OF RATS FED IRRADIATED OR CONTROL FOODS. Final Report. Ian J. Tinsley, Edward C. Bubl, Joseph S. Butts, and Jesse F. Bone (Oregon State Univ., Corvallis). Sept. 1, 1954. Contract DA-49-007-MD-580. 31p.

The wholesomeness of irradiated pork, jam, flour, carrots, and peaches was evaluated in long-term feeding experiments in rats. Rations containing each irradiated food were compared with a ration containing the corresponding unirradiated food. Data are summarized on growth rate, food efficiencies, longevity, breeding, and hematology. No detrimental effect which could be associated with the irradiated foods was seen in groups fed irradiated pork, peaches, jam, or flour rations. Results in the group fed irradiated carrots were inconclusive. (C.H.)

6270 (NP-11283) LONG-TERM RAT FEEDING STUDIES: IRRADIATED CHICKEN STEW (CS) AND CABBAGE (C). Final Report. A. W. Phillips, H. R. Newcomb, and D. Shanklin (Syracuse Univ., N. Y. Biological Research Labs.). Aug. 15, 1961. Contract DA-49-007-MD-783. 64p.

Toxicological evaluations of diets containing beef stew and raw cabbage, previously treated with 2.79 or 5.58 megarads of γ rays, were conducted on 4 generations of rats. Growth data revealed no marked difference between irradiated diet and control groups. A slight difference in weight gains was seen in 2nd and 3rd generation females. No statistically significant differences were found in breeding performance, survival time, hematological values, or gross pathology of organs. Data are tabulated. (C.H.)

6271 (TID-14571) PROCEEDINGS OF THE FIRST SYMPOSIUM ON THE NUCLEAR ACCIDENT DOSIMETRY PROGRAM: TECHNIQUES AND USES, HELD AT THE MIRAMAR CONVENTION CENTER AND THE SANTA BARBARA LABORATORY OF EDGERTON, GERMESHAUSEN AND GRIER, INC., SANTA BARBARA, CALIFORNIA, OCTOBER 5-6, 1960. (Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.). Contract [AT(29-1)-1183]. 204p.

Proceedings of the First Symposium on the Nuclear Accident Dosimetry Program: Techniques and Uses are presented. Topics covered include justification of the general system, descriptions of gamma and neutron systems, energy-response calculations of threshold-detector units, radiation-leakage calculations for critical assemblies, radiation leakage and Na^{24} activation, dosimetry of recent radiation accidents, status of UCC film badge, visual chemical indicator for gamma radiation, development of radiation belt, fireproof package for threshold-detector units, maintenance of capability, accidents, criteria for dosimetry placement, packagings, placement and recovery, calibration and counting of foils, and gamma read-out system and requirements. (M.C.G.)

6272 LEUKEMOGENIC EFFECT OF MYLERAN ON THE MOUSE THYMUS. A. C. Upton, F. F. Wolff, and E. P. Sniffen (Oak Ridge National Lab., Tenn.). Proc. Soc. Exptl. Biol. Med., 108: 464-7(Nov. 1961).

Myleran given before or after whole-body x irradiation increased the incidence of thymic lymphomas and decreased the incidence of myeloid leukemias in male mice of the RF strain. The magnitude of these effects varied, depending on the time Myleran was administered in relation to irradiation. Effects were greatest when Myleran was given 15 days before exposure to x rays. These results are paradoxical in view of the myelotoxic action of Myleran and attest further to the complexity of factors influencing susceptibility to radiogenic leukemia. (auth)

6273 MEASUREMENT OF THE DOSES ABSORBED BY THE PITUITARY IN VARIOUS RADIATION CONDITIONS. L. Papagni, F. Costa, and B. Roseo (Istituto di Radiologia dell'Ospedale Maggiore, Milan and Università, Milan). Radiol. med., 47: 850-4(Sept. 1961). (In Italian)

Using a dry skull filled and covered with a mixture of beeswax and paraffin, the authors measured the doses absorbed by the pituitary under the following irradiation conditions: x-ray therapy with radiations of HVL 0.8 mm Cu; x-ray therapy with radiations of HVL 1.75 mm Cu; telecesiotherapy; telecobalt-therapy; pendular irradiation with x-rays of HVL 1.22 mm Cu; pendular irradiation with Cs^{137} and Co^{60}. The data are reported in tables. (auth)

Biochemistry, Nutrition, and Toxicology

6274 (AFSWC-TDR-61-105) METABOLISM OF RUTHENIUM IN THE RAT. Technical Documentary Report. Joseph E. Traynor and Sidlee W. Leeper (Air Force Special Weapons Center, Kirtland AFB, N. Mex.). Dec. 1961. 13p.

Seventeen Sprague-Dawley rats were injected intramuscularly and intraperitoneally with ruthenium-106. The amount of this isotope was determined daily for 5 weeks in the urine and feces. Animals were sacrificed at intervals and the various organs were analyzed for ruthenium. It was noted from this experiment that the pathways of absorption, metabolism, and excretion are dependent on the route of administration of ruthenium. (auth)

6275 THE DETERMINATION OF THYROID HORMONES ON PAPER CHROMATOGRAMS BY NEUTRON ACTIVATION. H. Staerk and D. Knorr (Universitäts-Klinik, Munich). Atomkernenergie, 6: 408-11(Oct. 1961). (In German)

Iodine or iodine-containing compounds, such as thyroid hormones in human serum, can be traced quantitatively on chromatograph paper by activation with thermal neutrons. The induced iodine-128-activity is separated radiochemically. The limit of detection is between 10^{-10} and 10^{-9} g of iodine per cm^2 of paper. (auth)

6276 DISTRIBUTION AND DYNAMICS OF RUBIDIUM-86 IN "INBRED" RAT STOCK OF THE WISTAR RACE. H. Mabille, J. Martin, and C. Burg (Faculte de Medecine, Nancy, France). Compt. rend. soc. biol., 155: 561-5(1961). (In French)

The tissue distribution of rubidium and its chronological variations show marked differences between the different tissues. The initial fixation and its further decrease are very closely connected, if not in linear dependence. The close correspondence, from the fourth day, of the curve of muscle fixation and of red cells in the experimental animals is very important. The obtention of a correct image of the dynamics of rubidium in the muscle can thus be obtained. It is evident that if this parallelism is maintained in man, in particular in pathological circumstances, there is a possibility of following the muscle metabolism of this isotope. (tr-auth)

6277 STUDY OF THE DISTRIBUTION OF RADIOACTIVE RUBIDIUM (Rb^{86}) IN MAN. H. Mabille, F. Streiff, A. Larcan, and P. Michon (Clinique Medicale A, Nancy, France). Compt. rend. soc. biol., 155: 571-4(1961). (In French)

The distribution of Rb^{86} was studied in five adult males considered free of illnesses perturbing electrolytic metabolism. After injection of Rb^{86} the urinary excretion and the blood distribution were studied. Intravenous injection of 300 μc of Rb^{86} causes a low urinary excretion, a rapid disappearance of the plasma radioactivity, and a progressively slow and enduring flobular fixation, and finally a tissue fixation, particularly muscular and hepatic. (J.S.R.)

6278 PHYSICAL BASES OF RADIATION THERAPY OF TODAY AND TOMORROW. R. Wideroee (Universität, Zurich). Fortschr. Gebiete Röntgenstrahlen u. Nuklearmed., 95: 539-53(Oct. 1961). (In German)

The essential properties of x rays, electron beams, and high energy radiations are compared. For low-lying tumors, 30-Mev betatron x rays are more advantageous than cobalt γ rays. Electron beams with controllable energy up to 40 Mev are more favorable in many cases. The clinical experiences with electron treatment during the last 3 or 4 years have given good results, which partially differ from those of experiences with radiations with wave characteristics. An attempt was made to explain these differences by distribution of the ions formed. The irradiations of 187-Mev protons permit deep doses to be obtained and give isodose curves clearly more favorable than all other radiations used up to the present. The ion distribution from this irradiation seems to improve the treatment conditions and the results of preliminary biological examinations are promising. In order to cover the high costs of proton treatment – a proton accelerator is almost 12 times as expensive as a 40-Mev betatron for electron treatment – it is proposed that a European Research Center be founded for the study of radiation usable in medicine and biology. (tr-auth)

6279 BEHAVIOR OF SOME IMMUNO-HEMATOLOGICAL TESTS IN PATIENTS SUFFERING FROM NEOPLASMS TREATED WITH TELECOBALTTHERAPY. I. BEHAVIOR OF THE ANTIERYTHROCYTE ANTIBODIES. F. Carrera and C. Martinenghi. Minerva nucleare, 5: 192-6(Aug. 1961). (In Italian)

The results of researches on some immuno-hematologic tests, mainly concerning the formation of anti-erythrocyte antibodies, in patients with tumors treated by irradiation with high doses of telecobaltotherapy are presented. The radiation doses given to the whole body (total dose), to the blood and its plasmatic and corpusculated components, to the hemopoietic organs, to the blood-destroying organs, and to the reticulo-endothelial system under the different conditions of irradiation at the different sites, and extension of the tumor were calculated. With the doses used in the present series, no significant variations were observed in the majority of cases; further follow-up studies will be performed in these patients. (auth)

6280 INVESTIGATIONS ON THE ACTION OF ALPHA PARTICLES ORIGINATING FROM THE INTERACTION OF

THERMAL NEUTRONS WITH BORON. A. Laconi, G. Campesi, and E. Oliveri (Università, Palermo, Italy). Minerva nucleare, 5: 196-202(Aug. 1961). (In Italian)

The purpose of the present investigation was to determine radiolesions by means of alpha particles produced by the inter-reaction of natural boron with thermal neutrons. A number of studies on this problem have been reported in the literature in which, however, boron-10, which has a greater capacity to capture neutrons, was used. Experiments were performed in 15 rats. A group of animals was given a clyster containing approximately one gram of boric acid suspended in vaseline oil. The rats thus prepared with boron suspension were then placed in a nuclear reactor together with the controls and were submitted to the action of a beam of neutrons. Different irradiation times were used. Serial histologic controls were made at different intervals. In all the boron-treated irradiated rats very severe intestinal changes were observed only in those parts in which the boron suspension had penetrated. Normal findings were obtained in other parts of the intestine and in the other tissues, as well as in animals treated with boron alone. (auth)

6281 INCORPORATION OF IRON (Fe^{59}) BY RAT BONE MARROW MEGAKARYOCYTES IN VIVO AFTER ADMINISTRATION OF CYSTEAMINE BEFORE IRRADIATION. S. K. Brahma, A. Bose, and S. Bose (Chittaranjan National Cancer Research Centre, Calcutta). Naturwissenschaften, 48: 631(1961). (In German)

It was previously reported (Naturwissenschaften 48, (1961)436) that radiation caused an increase in Fe^{59} uptake in rat bone marrow megakaryocytes. In the present study the effect of cysteamine injection immediately before irradiation on Fe^{59} uptake was reported. Albino rats were exposed to whole-body irradiation of 500 r and the Fe^{59} uptake was determined. A marked difference was observed from the previous study. It appears that cysteamine offers protection against radioinduced stimulation at the level of iron incorporation. (J.S.R.)

6282 DISCRIMINATION IN INTESTINAL ABSORPTION OF STRONTIUM AND CALCIUM. Ray F. Palmer and Roy C. Thompson (General Electric Co., Richland, Wash.). Proc. Soc. Exptl. Biol. Med., 108: 296-300(Nov. 1961). (HW-SA-2223)

Absorption of Sr^{85} and Ca^{45} was studied in the rat by the technique of in vivo intestinal perfusion. With no calcium added to the perfusion solution the percentage of Sr^{85} absorbed was about 0.3 that of Ca^{45}. With increasing levels of calcium in the perfusion solution, the percentage of Sr^{85} and Ca^{45} absorbed decreased; however, the ratio of percentage absorption of Sr^{85} to Ca^{45} increased, reaching a value of about 0.6 in 25 mm calcium solution. There was no evidence of discrimination in the reverse movement of Sr^{85} and Ca^{45} from blood to intestine. The discrimination which occurs in the absorption process would appear to be a dominant factor in determining over-all strontium calcium relationships. (auth)

6283 EFFECT OF COMBINED USE OF CALCIUM GLUCONATE AND AMMONIUM CHLORIDE ON REMOVAL OF Sr^{85} IN MAN TWO WEEKS AFTER EXPOSURE. Herta Spencer, Arthur Feldstein, and Joseph Samachson (Montefiore Hospital, New York). Proc. Soc. Exptl. Biol. Med., 108: 308-12(Nov. 1961).

Studies of the removal of radiostrontium (Sr^{85}) from man have been carried out under controlled dietary conditions with the combination of orally administered ammonium chloride and intravenously infused calcium. Each agent alone increased Sr^{85} excretion 2 weeks after administration of the tracer. The use of both agents in combination was more effective in removal of radiostrontium than either agent alone. The effectiveness of either modality of treatment greatly depended on the calcium metabolism of the individual. (auth)

6284 TECHNICAL AND PHYSICAL-DOSIMETRIC COMPARISONS BETWEEN A TELECOBALT THERAPY UNIT AND A VAN DE GRAAFF ELECTROSTATIC GENERATOR (2 Mev). R. Miceli, A. Corinaldesi, and G. Caretti (Università, Bologna). Radiobiol. radioterap. e fis. med., (3) 16: 182-200[1961]. (In Italian)

The physico-technical and dosimetric properties of a telecobalt therapy unit and a 2-Mev Van de Graaff generator were compared. The basic physico-technical difference, apart from the diverse nature of the radiations, are principally connected to the magnitude of the focal spot, the collimation of the radiation beam, and the dose distribution. In the dosimetric elements two factors are considered: the depth transmission rate and its modifications by the effect of various treatment parameters and of the material used for the phantom and the spatial distribution of the dose with particular reference to the isodose curve and the ionimetric penumbra at the boundary of the irradiated volume. The various experimental data obtained are analyzed and discussed. (tr-auth)

6285 BEHAVIOR OF IMMUNIZING HEMOAGGLUTININS IN PATIENTS SUFFERING FROM MALIGNANT NEOPLASMS AND SUBJECTED TO RADIATION THERAPY. L. Ciampelli, G. Abbozzo, and M. Donati (Università, Florence and Centro per la Trasfusion del Sangue ed Immunoematologia, Florence). Radiol. med., 47: 855-61 (Sept. 1961). (In Italian)

After a brief mention of the nature and genesis of immunizing hemoagglutinins, the authors report the percent values determined on the serum of patients suffering from neoplasms and the variations observed after radiation therapy. A fall of the percent values of the immunizing agglutinins is demonstrated at the end of radiation therapy, a fall which appears to be influenced more by the size of the body surface irradiated than by the dose administered or the anatomical site. (auth)

6286 NEW SCINTIGRAPHIC TECHNIC FOR DEMONSTRATION OF BETA EMITTERS FOLLOWING INTRACAVITARY INSTILLATION. Gunther A. Doehner (St. Vincent's Hospital, New York). Radiology, 78: 100-2(Jan. 1962).

A scintillation technique is described for the demonstration of P^{32} chromic phosphate following intracavitary instillation. Due to the higher penetration of its high-energy beta emission (average energy: 0.7 Mev; maximal energy: 1.7 Mev), it is suggested that radiophosphorus in planar distribution might be considered more bio-effective than radiogold. However, in this technique, it is necessary to remove the focalized collimator of a scintigraph (scanner) and to replace it by a cylindrical insert of 5 cm length, 2.5 cm diameter, and 0.5 cm thick. This arrangement demonstrates the distribution of the beta emitter, which can be registered scintigraphically or photoscintigraphically. (P.C.H.)

6287 EXPERIMENTAL ANIMAL INHALATION STUDIES WITH RADIOACTIVE ZIRCONIUM. Walter Schiessle, Kurt Philipp, Ursula Jung-Langhorst, and Ingeborg Schmidtke (Universität-Klinik and Universität, Freiburg i. B.). Strahlentherapie, 116: 566-84(Dec. 1961). (In German)

A suitable arrangement for inhalation experiments in animals, using radioactive labeled aerosols, is described.

To date, experiments with P^{32}, I^{131}, and Zr^{95} have been used. Results are described, and the distribution pattern is discussed, using zirconium, a material foreign to the body. (auth)

6288 STUDIES OF THE BIOLOGICAL BEHAVIOR OF RADIOACTIVE FISSION PRODUCTS IN PREGNANT ANIMALS. PART IV. PLACENTAL TURNOVER OF RADIOYTTRIUM AND RADIOCERIUM IN RATS. Heinz Kriegel and Elisabeth Weber (Heiligenberg/Instituts, Heiligenberg/Baden, Ger.). Strahlentherapie, 116: 620-7(Dec. 1961). (In German)

The dependence of placental turnover of radio-yttrium and radio-cerium upon the day of incorporation before and during the gestation period was investigated in swine. There is a statistically significant positive correlation between the amounts of radioisotope deposited in the embryo and the weight of the embryo. However, a placental turnover can be found only if the incorporation through the mother-animal occurs during the last quarter of the gestation period. The values of the radio-yttrium deposits in the embryo are higher by one order than those of the radio-cerium deposits using comparable experimental conditions. (auth)

Radiation Effects on Living Tissues

6289 (CRB-1060) INFORMATION MEETING ON RADIATION BIOLOGY. (Organized for the National Research Council Associate Committee on Radiation Biology, held at the Chalk River Project, August 24, 1961). Howard B. Newcombe, comp. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nov. 1961. 40p. (AECL-1401)

Abstracts are included of 18 talks which were presented at the meeting and which deal with radiation effects on lower organisms and with human population studies. (D.L.C.)

6290 (AEC-tr-4955) THE COMPARABILITY OF RADIOPHYSIOLOGICAL STUDIES IN HIGHER PLANTS. R. Biebl and T. V. Kreybig (Kregbig). Translated by Lydia Venters (Argonne National Lab., Ill.) from Atompraxis, 7: 284-8(Aug. 1961). 11p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 15, abstract no. 29012.

6291 (JPRS-1132) RADIOBIOLOGY. Translation of Radiobiologiya, 1: No. 2, 153-318(1961). 453p.

6292 (JPRS-11322(p.1-21)) INVESTIGATION OF CHANGES IN THE POLYMERIZATION SPECTRUM OF DNA UPON IRRADIATION IN VIVO AND UNDER THE INFLUENCE OF DNASE ACTION IN VITRO. V. A. Struchkov and A. M. Kuzin. Translated from Radiobiologiya, 1: No. 2, 153-60(1961).

By means of the method of column chromatography with the use of ECTEOLA-cellulose, it was shown that the polymeric spectrum of the rat thymus DNA isolated 10 min following the irradiation of animals in a dose of 1000 r is the same as before irradiation in the normal. Distinct changes of rat thymus DNA are observed by this method only 24 hr after irradiation. The polymerization spectrum of DNA isolated from the spleen 24 hr after irradiation was very near to the DNA spectrum from unirradiated animals. It was shown that the observed changes of the polymerization spectrum of DNA isolated 24 hr after irradiation from the thymus of the irradiated rats (1000 r) almost completely coincide with the changes caused by the initial stages of enzymatic degradation of DNA. It was demonstrated that deep enzymatic depolymerization of DNA yields a polymerization spectrum which is not observed in the experiments with irradiation even at a dose of 70 kr. It was suggested that a non-deep depolymerization of DNA molecules in the tissues of an animal within several hours after its irradiation is not a result of a direct action of ionizing radiation upon the molecules of DNA, but represents a consequence of a secondary effect of DNAses activated by the irradiation. (auth)

6293 (JPRS-11322(p.22-54)) EXPERIMENTAL STUDY OF THE ROLE OF FREE RADICALS AND OF THE DIRECT EFFECT IN THE PRIMARY MECHANISM OF RADIATION ACTION. B. N. Sidorov, N. P. Dubinin, and N. N. Sokolov. Translated from Radiobiologiya, 1: No. 2, 161-71 (1961).

Evidence is presented that with the actual number of free radicals which are formed in the cell as a result of water radiolysis (taking into account the microgeometry of their distribution in the cell and the presence in it of protective substances intercepting the radicals), these radicals do not play in any degree a perceptible role in causing genetic effects. This is an important indication pointing to the fact that radiation affects the structure of chromosomes predominantly through a direct action. (auth)

6294 (JPRS-11322(p.55-68)) EFFECT OF IONIZING RADIATION UPON THE POLYMOLECULAR STRUCTURE OF DEOXYRIBONUCLEIC ACID IN THE LIVING CELL. V. A. Struchkov and N. B. Strazhevskaya. Translated from Radiobiologiya, 1: No. 2, 172-5(1961).

The polymolecular structure of DNA was isolated from the bone marrow and erythrocytes of chickens by a phenol extraction method. It was shown that there exists a considerable (50%) disturbance of the polymolecular structure of DNA in erythrocytes and bone marrow of chickens, as well as in Ehrlich's ascitic cancer of mice, immediately after a total irradiation of animals with a lethal dose. The polymolecular structure of DNA from the radiosensitive (bone marrow) and from the radioresistant (erythrocytes) tissue is affected in an equal degree during the first hours after irradiation. It was suggested that the rapidly occurring disturbance of the polymolecular structure of DNA is of essential importance in the radiation damage of the cell. (auth)

6295 (JPRS-11322(p.69-85)) STUDY OF THE ELECTRICAL CHARACTERISTICS OF RAT LIVER AFTER RADIATION INJURY. A. I. Polivoda and A. A. Mikhailova (Mikhaylova). Translated from Radiobiologiya, 1: No. 2, 176-81(1961).

Results are described from a series of measurements of electrical changes in liver of irradiated rats and in liver tissue extracts from freshly-killed rats exposed to the same Co^{60} gamma source. An attempt is made to relate certain submicroscopic changes in the rat liver at various periods following irradiation with changes in electrical characteristics of the tissue. It is concluded that submicroscopic structural changes occur during the first 24-hr period after irradiation and are present before visible morphological, biochemical, or other indications of radiation damage. (C.H.)

6296 (JPRS-11322(p.86-99)) EFFECTS OF ACETYLCHOLINE UPON RESTORATION IN VITRO OF PHOSPHOLIPIDS OF THE LIVER OF RATS SUBJECTED TO GAMMA IRRADIATION. N. N. Demin and A. S. Kainova (Kaynova). Translated from Radiobiologiya, 1: No. 2, 182-6(1961).

Acetylcholine (AC) at a concentration of 10^{-2} to 10^{-10} in vitro decreased the restorability of the individual phospholipids of the liver of normal rats. After the whole-body gamma irradiation of rats in a dose of 800 r, AC at concen-

trations of 10^{-7} and 10^{-10} during the first 24 hours following irradiation increased the intensity of the metabolism of lecithins and cephalins while not affecting the restoration of inosite-phosphatides and sphingomyelins. At a concentration of 10^{-4}, AC under the same conditions also inhibited the metabolism of lecithins and cephalins. AC affected only weakly the relationship between the content of individual phospholipids of the liver in the normal and irradiated rat. In the latter case it slightly intensified the changes occurring in the relative content of lecithins and cephalins. (auth)

6297 (JPRS-11322(p.100-19)) ON THE ENDOGENOUS FORMATION OF CARBON MONOXIDE. V. V. Kustov, I. A. Gofman, and F. A. Ivanova. Translated from Radiobiologiya, 1: No. 2, 187-92(1961).

In the experiments on white rats and rabbits it was shown that during radiation sickness an elevated content of carbon monoxide in the blood is observed. The degree of radiation carboxyhemoglobinemia depends upon the period of radiation sickness. The radiation carboxyhemoglobinemia is connected with an elevated endogenous formation of carbon monoxide during radiation sickness. During irradiation of the blood in vitro with x rays in a dose of 5000 r there occurs an endogenous formation of carbon monoxide. (auth)

6298 (JPRS-11322(p.120-41)) DECREASE OF THYMINE IN DNA OF PISUM PLANTULES IRRADIATED WITH GAMMA RAYS. V. I. Tokarskaya. Translated from Radiobiologiya, 1: No. 2, 193-9(1961).

In dry seeds and seven-day plantules of Pisum, after gamma irradiation with 10 kr, there occurs a decrease of the amount of thymine with an invariable amount of adenine which leads to the alteration of the normal ratio of nucleotides in the DNA. The ratio A/T, equal in the control approximately to unity, increases following irradiation to 1.69 (in dry seeds) and to 1.65 in the plantules of Pisum. The ratio G/C increases, on the average, to 1.4 while in the control it is equal to 1.04. There was found a sharp retardation of the incorporation of thymine into DNA newly synthesized after irradiation. The ratio of the specific activity of adenine to the specific activity of thymine is equal to 2.7, while in the control the incorporation of the label proceeds approximately equally into all bases of DNA. Thus, this synthesis does not lead to the formation of DNA of the normal type. On the basis of the analysis of the data, assumption is made that, as a result of gamma irradiation, there occurs damage of the structure of DNA which leads to a disturbance of the complementary character of the polynucleotide chains. On such an imperfect matrix, apparently, a qualitatively altered DNA is synthesized. (auth)

6299 (JPRS-11322(p.142-61)) ON THE RADIOSENSITIVE LINKS IN THE SYSTEM OF OXIDOREDUCTION ENZYMES OF THE CELL ASSOCIATED WITH MITOCHONDRIA. N. A. Pomoshchnikova and T. S. Sokolova. Translated from Radiobiologiya, 1: No. 2, 200-5(1961).

The oxidation-reduction systems of the cell, connected with mitochondria, have different sensitivity to radiations. The system of dehydrogenases reducing Janus green was found to be most easily affectible. Less sensitive to irradiation is the process of reduction of neutral red with yeast cells. The cytochrome oxidase system is extremely resistant. The system which reduces Janus green and belongs to DPN dehydrase systems is very sensitive to radiations. It is possible that an early damage of this system plays a decisive role in the radiation reaction of the cell. The conditions of a preliminary cultivation of yeast organisms affect the radiosensitivity of oxidoreduction systems of the cell. Under anaerobic cultivation of yeasts, the divergence between the sensitivity to irradiation of the cytochrome oxidase and reductase systems is considerably greater than under aerobic growth. (auth)

6300 (JPRS-11322(p.162-79)) STUDY OF THE PROPERTIES OF MYOSIN OF MUSCLE TISSUE IRRADIATED WITH Co^{60} IN VITRO. V. V. Pal'min and L. T. Alekhina. Translated from Radiobiologiya, 1: No. 2, 206-11(1961).

It was established that myosin preserves its native properties to a considerable extent, viz.: solubility, enzymatic activity, and participation in the contractile processes, upon irradiation of the autolyzing muscle tissue with Co^{60} γ rays in a dose ranging from 1.1 to 1.3 million r, in contrast to myosin irradiated in solutions. The data obtained indicate that myosin is present in the structure of autolyzing tissue in a state which is apparently little accessible both to the action of direct radiation as well as to the action of the active products of water radiolysis. (auth)

6301 (JPRS-11322(p.180-213)) EVOLUTIONARY COMPLICATION OF RADIOBIOLOGICAL AFTER EFFECTS AND THE ROLE OF THE NERVOUS SYSTEM IN RADIATION SICKNESS. A. L. Shabadash. Translated from Radiobiologiya, 1: No. 2, 212-22(1961).

The radiobiological reactions of complex organisms of animals cannot be reduced to the mechanisms of biological response at the cell level. At various stages of radiation disease there occurs the change of leading links in the successive chain of processes. The evolutionary development of the nervous system produces predominant regulation of the occurrence and development of radiation sickness which is especially marked in higher vertebrates. The immediate alterations due to the action of penetrating radiations in neurons of the consecutively connected (reflex and trophic) centers of coordination of functions in mammals are cytochemically proven. Radiation sickness in man and animals must be considered as a special type of cyclic trophoneurosis with an extreme inhibition of regenerative processes; the local irradiation of higher centers of vegetative innervation and regulation (or a total one of the whole organism) produces a multiple interference of direct radiation and the radiomimetic processes. (auth)

6302 (JPRS-11322(p.214-26)) EFFECT OF LONG-ACTING CONDITIONED STIMULI PREVIOUSLY COMBINED WITH X-RAY IRRADIATIONS UPON THE LEUKOCYTE AND LYMPHOCYTE CONTENT IN THE PERIPHERAL BLOOD. N. N. Livshits and E. (Ye.) S. Meizerov (Meyzerov). Translated from Radiobiologiya, 1: No. 2, 223-6 (1961).

Conditioned stimuli, earlier combined with x-ray irradiations, and their aftereffect produce a decrease of the content of leukocytes and lymphocytes in the peripheral blood. This confirms the participation of the reflex link in the changes of the morphological composition of the blood caused by the action of ionizing radiation. (auth)

6303 (JPRS-11322(p.227-47)) MORPHOLOGICAL CHANGES IN THE CENTRAL NERVOUS SYSTEM OF DOGS AT THE INITIAL STAGES OF CHRONIC RADIATION SICKNESS. A. G. Khanin. Translated from Radiobiologiya, 1: No. 2, 227-32(1961).

Results are reported from a series of studies on morphological changes in the central nervous system of dogs during the early stages of chronic radiation sickness. Pathological changes were more pronounced in the cerebrum than in the spinal cord. Morphological changes observed are described in detail. (C.H.)

6304 (JPRS-11322(p.248-73)) EFFECTS OF SMALL DOSES OF IONIZING RADIATION UPON THE PROCESSES OF INTERNAL INHIBITION IN DOGS. I. A. Piontkovskii

(Piontkovskiy) and M. G. Airapetyants (Ayrapetyants). Translated from Radiobiologiya, 1: No. 2, 233-41(1961).

X irradiation of the parietal regions of the head in dogs with a dose of 10 r is accompanied by distinctive changes of the conditioned-reflex activity during two to six weeks. Weakening of all forms of internal inhibition, shortening of latent periods of conditioned reflexes, and a certain increase of their values is noted during the first hour after irradiation and attains a maximum in the second 24-hour period. In the fourth to fifth 24-hour period, there occurs an apparent restoration of the conditioned-reflex activity. A special test (prolongation of differentiation) reveals a relative weakness of cortical inhibition also in this period. Characteristic of the course of conditioned-reflex activity of animals after irradiation are pronounced periodicity, cyclicism, and waviness of variations, which at times are very insignificant as to their intensity but relatively prolonged, while against the background of seemingly already completely restored higher nervous activity the disturbances repeat themselves again and again without any apparent reason, now in the form of a decrease and then in the form of an increase of reflexes with a weakening of active inhibition. (auth)

6305 (JPRS-11322(p.274-87)) INVESTIGATION OF GAS METABOLISM IN IRRADIATED ANIMALS PERFORMING MUSCULAR WORK. I. V. Bondarenko. Translated from Radiobiologiya, 1: No. 2, 242-6(1961).

In dogs exposed to whole-body single irradiation with x rays in a dose of 250 r, there was noted a decrease of both oxygen consumption and liberation of carbon dioxide during the entire course of radiation sickness. As a result of the application of physical load, in the irradiated dogs as well as in nonirradiated ones there developed an increase of gas metabolism and respiration. There exist, however, certain differences as to the degree of increase of these indicators. On the first day after irradiation, the increase of gas metabolism and respiration is a little less pronounced, and on the 15th day of radiation sickness it is considerably more marked than in the nonirradiated animals. At the peak of radiation sickness, there was observed a considerable prolongation of the period of restoration of gas metabolism, which apparently indicates an increase of oxygen consumption. (auth)

6306 (JPRS-11322(p.288-96)) CHANGES OF HISTAMINOPEXIC CAPACITY OF THE BLOOD IN IRRADIATED DOGS. K. M. Larionova. Translated from Radiobiologiya, 1: No. 2, 247-9(1961).

Whole blood, in the same way as blood serum, has a histaminopexic capacity. The total irradiation of dogs in doses of 300 to 400 r leads to a sharp inhibition of the histaminopexic capacity of the blood. (auth)

6307 (JPRS-11322(p.297-315)) DEPENDENCE OF THE BIOLOGICAL ACTION OF PLUTONIUM UPON THE RHYTHM OF ITS ENTRY INTO THE ORGANISM. Yu. I. Moskalev, L. A. Buldakov, and V. N. Strel'tsova. Translated from Radiobiologiya, 1: No. 2, 250-6(1961).

The duration of life of rats poisoned by plutonium depends not only on the dose but also on the rhythm of the introduction of isotope. Upon administration of plutonium in a dose of 0.00125 μcurie/g, the average duration of life of rats does not change and does not depend upon the rhythm of the intake of the isotope. On introduction of plutonium in a dose of 0.005 to 0.08 μcurie/g, fractional administration prolongs the duration of life of the animals. The prolongation of the life of animals appears to be higher in the fractionation of large doses of plutonium. Upon the fractional introduction of plutonium the values $LD_{50/120}$ and $LD_{50/30}$ increase (from 0.025 and 0.007 μcurie/g in single administration of isotope to 0.06 and 0.01 μcurie/g in fractionated introduction). The changes of body weight and hematological indicators in animals poisoned by plutonium upon protracted administration of the isotope appear at first less pronounced but at the later periods, after introduction of the isotope is discontinued, the differences become obliterated. Upon the administration of plutonium in a dose of 0.00125 μcurie/g at a remote period, the weight of the experimental animals appears to be higher than that of the controls. In fractionated introduction of the isotope, the increase of the weight of rats is more sharply pronounced. Upon the administration of plutonium in a dose of 0.00125 to 0.02 μcurie/g, tumors of the bony tissue develop both in single and prolonged introduction of the isotope. A suggestion is made in this report concerning the role of the density of ionization in the occurrence of the tumors of bony tissue. (auth)

6308 (JPRS-11322(p.316-36)) STUDY OF THE STATE OF THE ACID-BASE EQUILIBRIUM IN ACUTE RADIATION SICKNESS. L. N. Mar'ich (Mar'yich). Translated from Radiobiologiya, 1: No. 2, 257-63(1961).

The experimental investigation performed shows that upon whole-body X ray irradiation of the rabbits in doses of 1300 r, 1000 r, and 700 r there occur sharp shifts of the acid-base equilibrium in the direction of acidosis. There is no doubt that the acidotic shift observed both at an early period as well as before death of the animals (1300 r) is a result of the disturbance of all forms of metabolism, i.e., an increased formation and accumulation in the organism of suboxidized compounds which bring about the exhaustion of the alkaline reserves. It is also beyond doubt that the second cause of acidosis is a disturbance of all regulatory mechanisms. However, on the basis of the data one may affirm that one of the causes of acidosis produced by penetrating radiation is an early disturbance of the functional activity of the kidneys, connected with regulation of the acid-base equilibrium. The investigation of acid-base equilibrium according to the above-mentioned indicators permits to judge on the character of the metabolism in the organism and provides a satisfactory qualitative evaluation of the pathological processes occurring in the kidneys. For this reason, the use of such a systematic and complex investigation might be of practical significance for the control of the therapy of acute radiation sickness. (auth)

6309 (JPRS-11322(p.337-52)) QUANTITATIVE EVALUATION OF RADIATION INJURY IN CRYPTS OF THE MUCOUS MEMBRANE OF THE SMALL INTESTINE. I. B. Smirnova. Translated from Radiobiologiya, 1: No. 2, 264-9(1961).

A quantitative evaluation of the destructive and restorative processes developing in the epithelium of the crypts of the mucous membrane of the intestine of white mice at various periods after irradiation with x rays (700 and 1000 r) was effected. The total number of epithelial cells lining the crypt on a strictly transverse section across the duodenum, the mitotic index of these cells, and the percentage of cells with bridges and acentric fragments were calculated to serve as criteria. Irradiation causes a mass disintegration of cells in the crypts of the intestine, which attains its highest value (55% of the normal) 24 hours after irradiation with a dose of 700 r, and after 1000 r it reaches, respectively, 67% within 48 hours. This disintegration is accompanied by the accumulation of debris in the lumens of crypts. At the subsequent periods after irradiation, with a dose of 700 r, a gradual restoration of the numerical strength of the cells is being observed. After 1000 r, the beginning of restoration may be observed by the third 24-hour period. The mitotic activity of epithelial cells of the

crypts, which is sharply lowered in the next hours after irradiation with a dose of 700 r is practically normalized already after 24 hours. After 72 hours, the mitotic index exceeds substantially that in the normal. The number of cells with bridges and acentric fragments, which reaches in the first hours after irradiation with a dose of 700 r approximately 84%, gradually decreases during subsequent periods. A very great stability of the selected criteria in the normal and at the corresponding periods after irradiation permits to assume that the number of cells lining the crypts, calculated on its strictly transverse section, mitotic index, and percentage of cells with chromosome aberrations in the intestinal epithelium, represent convenient and accurate indicators which permit to evaluate objectively the state of epithelium of the crypts of the mucous membrane of the intestine in the irradiated animals. (auth)

6310 (JPRS-11322(p.353-74)) ANTIRADIATIVE ACTION OF PROTECTIVE AGENTS AND THE "OXYGEN EFFECT." E. Ya. Graevskii (Grayevskiy) and M. M. Konstantinova. Translated from Radiobiologiya, 1: No. 2, 270-7(1961).

Data are reviewed on reaction mechanisms involved in the radioprotective effects of a number of agents. The influence of oxygen on radiosensitivity is discussed. Results are reported from a series of studies in mice exposed to lethal doses of γ radiation immediately after the administration of a radioprotective agent. The effect of the agent upon oxygen pressure in the tissues and upon the survival time of the mice was compared. The agents included reducing agents, such as ascorbic acid, pyrogallol, and hyposulfite; potassium cyanide, which produces histotoxic hypoxia; substances producing hemic hypoxia, such as carbon monoxide and sodium nitrate; adrenaline, heroin, and morphine; dimercapto compounds; monothiol compounds; and hypothermia. The protective effect produced by the majority of the agents was accompanied by a decrease of the oxygen pressure of the tissues. It was concluded that hypoxia is the factor which determines the radioresistance of animals. (C.H.)

6311 (JPRS-11322(p.375-90)) EFFECTS OF PROTECTIVE AGENTS UPON THE MITOTIC ACTIVITY OF THE CORNEAL EPITHELIUM OF IRRADIATED MICE. O. P. Domareva. Translated from Radiobiologiya, 1: No. 2, 278-82(1961).

The prophylactic administration of the protective agents cysteine, β-mercaptoethylamine, and unithiol did not prevent the fall of mitotic activity in the corneas of mice due to irradiation. Upon the dropping of the protective agents directly onto the cornea, the percentage of pathological forms of mitoses decreased. (auth)

6312 (JPRS-11322(p.391-405)) ON THE PROTECTIVE EFFECT OF CYSTEINE HYDROCHLORIDE UPON RADIATION-INDUCED DEAMINIZATION OF GLYCINE IN AQUEOUS SOLUTIONS. N. A. Duzhenkova. Translated from Radiobiologiya, 1: No. 2, 283-7(1961).

The radiochemical yields of ammonia from glycine solutions, both in the presence of oxygen and without it, are practically identical. Consequently, no decrease of the yield of NH_3 is observed in the presence of oxygen. This apparently indicates that the HO_2 radicals which were formed as a result of the interaction of the H radical with oxygen play an essential role in deaminization and compensate for the absence of reduction (at the expense of H radicals) of deaminization which occurs in oxygen-free solutions. The protective effect of cysteine HCl is stronger in an acid medium than in the alkaline one. The process of deaminization of glycine in an acid medium was determined to be due primarily to the interaction of glycine cations with OH radicals, and in the alkaline medium to the interaction of glycine anions with H radicals. Reaction mechanisms in an acid medium proceed according to the scheme $HOH + OH + NH_3^+ \cdot CH_2 \cdot COOH \rightarrow NH_4^+ + HO \cdot CH_2 \cdot COOH + OH$. Reaction mechanisms in an alkaline medium proceed according to the scheme $HOH + H + NH_2 \cdot CH_2 \cdot COO^- \rightarrow NH_3 + HO \cdot CH_2 \cdot COO^- + H$. Upon introduction of cysteine HCl into the irradiated system, there begins a competition between it and glycine for the radicals forming in water radiolysis (H, OH, HO_2). It is known that the reactive capacity of sulfhydryl groups of cysteine HCl in relation to OH radicals is very great. Therefore, the deaminization of glycine should practically proceed only at the expense of H radicals. However, since in an acid medium the deaminization is due, according to the scheme, only to the reaction of OH radicals with glycine, this process in the presence of cysteine HCl practically does not occur, i.e., cysteine HCl completely protects the amino acid against the damaging effect of the radiation. (auth)

6313 (JPRS-11322(p.406-21)) PROPHYLACTIC EFFECT OF SODIUM ARSENATE IN POLONIUM POISONING. D. I. Zelyakova. Translated from Radiobiologiya, 1: No. 2, 288-92(1961).

Sodium arsenate in doses of 0.2 to 0.8 mg/kg, upon its multiple administration prior to poisoning by polonium, exerts a prophylactic effect in rats which is expressed by the increase of the duration of life, decrease of the loss of body weight, and a less marked change of the erythrocyte count in the peripheral blood. A most distinct prophylactic action is manifested upon administration of sodium arsenate in doses of 0.8 mg/kg during three weeks before intoxication by polonium. (auth)

6314 (JPRS-11322(p.422-8)) RATE AND DOSE DEPENDENCE OF THE FORMATION OF ANTIMITOTIC SUBSTANCES IN IRRADIATED LEAVES OF VICIA FABA. A. M. Kuzin and L. M. Kryukova. Translated from Radiobiologiya, 1: No. 2, 293-5(1961).

Investigations showed that in the irradiated leaves of 12 to 14 day-old plants of Vicia faba there occurs a disturbance of metabolism, leading to the appearance of abnormal metabolites which inhibit the division of cells in the apical points. These metabolites were demonstrated by the inhibition of mitoses in the apical points 3 to 4 hours following irradiation. The appearance of antimitotic substances is clearly discernible at doses of 500 to 1000 r of x radiation. (auth)

6315 (JPRS-11322(p.429-46)) EXPERIMENTAL MUTATIONS IN SPRING WHEAT AND THEIR SIGNIFICANCE FOR SELECTION. P. K. Shkvarnikov and I. V. Chernyi (Chernyy). Translated from Radiobiologiya, 1: No. 2, 296-303(1961).

The results of the analysis of the second generation of spring wheat obtained from seeds irradiated with thermal neutrons, gamma rays, and x rays permit to draw the following brief conclusion: the irradiation of seeds with each of the above-mentioned types of ionizing radiation produced increases of the frequency of the appearance of mutant individuals by 50 to 100 times as compared with their spontaneous occurrence. The highest numerical mutagenic effect was obtained from irradiation with certain doses of x rays, second place was occupied by the effect of gamma radiation, and the last one by the effect of thermal neutrons. (auth)

6316 (JPRS-11322(p.447-57)) COMPARATIVE STUDY OF THE MUTAGENIC ACTION OF GAMMA RAYS AND ETHYLENEIMINE. N. S. Eyges and S. A. Valeva. Translated from Radiobiologiya, 1: No. 2, 304-7(1961).

The comparison of the mutagenic effect of gamma rays and that of ethylenimine upon the seeds of winter rye of the PPG-186 variety has shown that ethyleneimine is 6.5 times more effective. Upon treatment with ethylenimine, mainly the same types of mutations occurred as upon treatment with gamma rays. However, several new forms were found. Upon treatment of the seeds of winter rye with ethylenimine, in the second generation the following agriculturally promising forms of mutants were isolated: large-eared, high-yielding, erectoids; forms ripening earlier or later than standard forms, as well as forms resistant to diseases. (auth)

6317 (JPRS-11322(p.458-62)) EFFECT OF X-RAY IRRADIATION OF LEAVES UPON THEIR UPTAKE OF P^{32}. S. O. Grebinskii (Grebinskiy) and K. A. Skvarko. Translated from Radiobiologiya, 1: No. 2, 308-9(1961).

The leaves of false acacia and honeysuckle showed a decrease in uptake of P^{32} following exposure to x irradiation. Data are tabulated. (C.H.)

6318 (JPRS-11322(p.463-7)) MUTAGENIC EFFECT OF METABOLITES FORMED IN AN IRRADIATED PLANT. L. M. Kryukova. Translated from Radiobiologiya, 1: No. 2, 310-11(1961).

It was shown that as a result of irradiation (25 kr) there appear in the leaves of Vicia faba substances which exert a mutagenic effect and produce chromosome aberrations in the cells of radicles of Pisum sativum. (auth)

6319 THE EFFECTIVE MECHANISM OF NERVE DAMAGE FROM IONIZING RADIATION AT LOW DOSES. W. Kroebel and K. Vanselow (Universität, Kiel). Atomkernenergie, 6: 385-96(Oct. 1961). (In German)

A summary is first made of known investigations on the effects of ionizing rays on nerve preparations. Then the theory is developed that the formation of action potential in nerves is the expression of a monostable system. There are generally valid characteristics for such systems which are independent from the special processes by which the monostability of the system is governed. These characteristics are derived from the functional properties of a monostable multi-vibrator used as an example for a monostable system. These characteristics form the basis for a comparison with the analogous processes during the signal formation at the nerves. This is done in order to trace back certain time intervals of the time function of the nerve signal to the partial phenomena underlying them. The conceptions obtained therefrom are used as the basis for the interpretation of radiation tests on nerve preparations. The radiation tests were performed on bundles of nerve fiber with the aid of x rays. The ischiadicus nerve of the frog was used as a preparation. The tests show that a damaging effect can be obtained not only with α rays, as was already demonstrated some time ago, with doses of as little as 10 to 15 r, but also with x rays, as the present tests show. The doses applied to achieve the same effect are approximately 60 r, which is in accordance with the lower ionization density in x rays. Radiation was performed with a tube voltage of 5 kv. The comparison of the results with the effects to be expected at monostable systems leads to the conclusion that the radiation damage observed is based on a disturbing influence on the metabolism system of the nerve. Apparently, the action respiration system is chiefly affected in such a way that the respiration speed is decelerated. (auth)

6320 THE EFFECT OF DOSE-RATE OF X-RAYS ON FILAMENT FORMATION IN ESCHERICHIA COLI. Mary O'Dile Cahoon, G. M. Clark, and D. G. Baker (Univ. of Toronto). Can. J. Genet. Cytol., 3: 424-35(Dec. 1961). (In English)

Escherichia coli, following x irradiation, showed an inhibition of cell division without complete inhibition of growth. At higher dose-rates there was less growth while at lower dose-rates the inhibition of division lasted longer. Filament formation was also observed when non-irradiated cells were incubated at 15°C. Desoxyribonucleic acid synthesis was inhibited by x irradiation and was resumed sooner when higher dose-rates were used. A proposed mode of action of irradiation which results in filament formation is discussed. (auth)

6321 A COMPARISON OF ENZYMIC FRAGMENTS OF RIBONUCLEIC ACIDS FROM TISSUES OF NORMAL AND IRRADIATED ANIMALS. S. Zadražil and Z. Šormová (Inst. of Organic Chemistry and Biochemistry, Czechoslovak Academy of Sciences, Prague). Collection Czechoslov. Chem. Communs., 26: 2651-9(Oct. 1961). (In English)

A comparison was made of the composition of fragments isolated from ribonuclease digests of RNA from liver tissue of normal and whole-body x-irradiated rats. Four hours after the end of irradiation the content of RNA was found to decrease up to 30% when compared with that of normal animals; at the same time the basic analytical characteristics remain essentially the same (the content of phosphorus, nitrogen, DNA, proteins, and amino acids, and the nucleotide composition and the absorption spectra). The qualitative composition of the enzymic digests is also identical. Marked differences between the two RNA's were found to lie in the amounts of some fractions (C, U, AAC, (GGA) U). Larger amounts of the latter were always contained in the hydrolyzate of RNA from the tissue of irradiated animals. The determined differences pertaining to the quantitative pattern of several fragments were discussed from the aspect of possible irradiation-induced changes in the inner arrangement of the polynucleotide chain of RNA. (auth)

6322 EVOLUTION OF RADIOCHIMERA ACCORDING TO WHETHER THE GRAFTED HEMOPOIETIC CELLS COME FROM BONE MARROW OR FETAL LIVER. J. F. Duplan and R. Monier (Institut du Radium, Paris). Compt. rend. soc. biol., 155: 712-16(1961). (In French)

The evolution of the radiochimeras XVII and AkR was followed by the electrophoretic determination of the characteristics of their hemoglobin. If the hematopoietic cells injected after the irradiation (800 r) come from AkR fetal livers, the mortality by homologous illness is very weak, but on the 200th day after the irradiation, mice have ceased being chimera (reject of the graft). On the other hand after the injection of bone marrow cells, almost all the radiochimeras die early of homologous sickness. (tr-auth)

6323 THE EFFECT OF GAMMA-RADIATION ON THE STRUCTURAL DEVELOPMENT OF THE SPINAL CORD OF THE CHICKEN EMBRYO. G. E. Sviderskaya (Sechenov Inst. of Evolution Physiology, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 141: 469-72(Nov. 11, 1961). (In Russian)

In a previous work it was found that by irradiating chicken embryos with γ-rays the spontaneous and reflex motions are interfered with although the over-all development of the motor functions remains unchanged. Morphological studies carried out at that time are reported. The White Leghorn embryos were irradiated at the age of 1, 4, and 7 days with doses ranging from 600 to 1500 r. The irradiation caused structural and cytochemical changes without interfering with the morphological and physiological differentiation processes of the spinal cord; this might be the reason for the observation that the development of the motor function is not interfered with. The retardation of the reflex and

spontaneous motor functions of the irradiated embryos is probably due to structural injury. (TTT)

6324 INJURY TO THE ENERGY METABOLISM IN PLANTS EXPOSED TO GAMMA RAYS. L. V. Metlitskii and E. G. Sal'kova (Bakh Inst. of Biochemistry, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 141: 485-7 (Nov. 11, 1961). (In Russian)

To establish whether radiation-induced damage in plants causes primarily a weakening of the oxidation processes or interference with the mechanism of storing energy in a form accessible for biochemical processes, the effect of radiation on the metabolism was examined. Previous tests indicated that irradiation of tubers results in an interference between the respiration and phosphorylase actions, as is the case with animals, microorganisms and certain plants. The problem was studied by exposing garlic bulbs to total γ-ray doses of 500 and 10,000 r. It was found that the type of tissue had a great effect on the rate of oxidation of organic acids. The phosphorylase activity is generally reduced by radiation; at 500 r phosphorus is not absorbed but is precipitated in the medium. Complete stoppage of the phosphorylase action by 500 r is due to the fact that garlic does not germinate; this action is depressed to a greater extent by radiation than oxidative processes. It is concluded that one of the chief effects of radiation is interference between oxidation and phosphorylase processes in the tissue because the energy obtained by respiration cannot be utilized completely by the plant cells. (TTT)

6325 OVARIAN FUNCTION AND HISTOLOGY AFTER X-RAY IRRADIATION IN ALBINO RATS. William G. Slate and James T. Bradbury (State Univ. of Iowa, Iowa City). Endocrinology, 70: 1-6(Jan. 1962).

Doses of x ray from 300 to 1500 r were delivered to the ovaries of adult female albino rats. The effects on the structures in the ovary associated with hormonal production and the estrous cycle were observed. Some observations were made on fertility. There was no immediate irregularity in the vaginal cycles after x irradiation regardless of the dose. Vaginal cycles disappeared progressively earlier with heavier doses. An occasional Graafian follicle or ovum was found after cessation of vaginal cycles, and in the presence of persistently cornified smears. With each higher x ray dose, the time interval for disappearance of follicles or ova was shortened. A dose of irradiation which would destroy the follicular structures and ova, and yet permit continuation of vaginal cyclic change, was not found. Using the ventral field of exposure and technique described, the MLD_{50} for the rats was between 1100 and 1200 r. (auth)

6326 BONE MARROW TRANSPLANTATION AS AN INDICATOR OF THE ABSENCE OF MITOSIS INHIBITORS IN IRRADIATED MICE. V. Drášil, Z. Karpfel, and J. Soška (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Folia Biol. (Prague), 7: 409-11(1961). (In English)

The proliferation of transplanted hematopoietic tissue was studied in mice irradiated with doses of 600 to 9600 r. It was found that the injected bone marrow proliferated in all the hosts, as seen from mitosis and the degree of DNA synthesis in the spleen and from the mitotic index in the bone marrow. These results are regarded as evidence that no substances capable of inhibiting mitosis in healthy, non-irradiated bone marrow cells are present in the irradiated organism. (auth)

6327 MECHANISM FOR THE INACTIVATION OF CRYSTAL LIVER ALCOHOL DEHYDROGENASE BY X-RAY BEAMS. A. Temperli, H. Aebi, and A. Zuppinger (Universität, Bern). Helv. Chim. Acta, 44: 1573-82(1961). (In German)

Radiation-induced inactivation of horse liver alcohol dehydrogenase in dilute aqueous solution was investigated (G-value ~ 0.2). Whereas the enzyme can be protected by the addition of reduced glutathion as well as by inert proteins, its sensitivity toward x rays can be increased by addition of small amounts of catalase. In radiation-induced inactivation there is a parallelism between the proportion of lost activity and thiol oxidation. After inactivation a partial regeneration of free SH-groups can be achieved, but this regeneration does not restore enzymatic activity. It is suggested that radiation induced inactivation is due to denaturation rather than SH-oxidation only. (auth)

6328 CARCINOMA OF SKIN IN BOVINE EXPOSED TO RADIOACTIVE FALLOUT. Carl F. Tessmer and Daniel G. Brown (Univ. of Tennessee Agricultural Experiment Station, Knoxville). J. Am. Med. Assoc., 179: 210-14(Jan. 20, 1962).

The first instance of malignant change in skin presenting long-term changes initiated by exposure to radioactive fall-out is reported in the bovine. Certain factors which tend to complicate any simple relationship between malignant degeneration and damage by prior radiation are pointed out, particularly in the tendency of this species to develop carcinoma of the skin of the orbital area and the existence of carcinoma of the skin elsewhere in this animal, probably prior to the malignancy in the area of damage by radioactive fall-out. (auth)

6329 THE PROBIT METHOD. ITS UTILIZATION IN EXPERIMENTATION ON MARROW GRAFTS. J. C. Lavigne and G. Lennes. J. belge radiol., 44: 479-84(1961). (In French)

Application of the LD_{50} proved to be an excellent formula for the study of tolerance variations of in-bred mice to total body irradiation, taking into account the different experimental factors able to be modified (and especially to increase) this tolerance. The preliminary tests gave good results. However, application of this "50% value of the lethal dose by x rays" requires a simultaneous and very exact statistical method. The principles of the method are described, and the first concrete results will be reported soon. (auth)

6330 AMINO ACID LEAKAGE AND AMINO ACID POOL LEVELS OF ULTRAVIOLET-IRRADIATED YEAST CELLS. Paul A. Swenson and David H. Dott (Univ. of Massachusetts, Amherst). J. Cellular Comp. Physiol., 58: 217-31(Dec. 1961).

A study was made of the effect of ultraviolet radiations on leakage of amino acids from yeast cells and on the amino acid pools of these cells. Results are tabulated. The significance of the findings is discussed. Leakage of amino acids from yeast cells following ultraviolet radiation is concluded to be a selective process influenced by the metabolic activity of the cell. Membrane damage probably occurs but it alone cannot account for the observed facts. (C.H.)

6331 THYROID NODULES OCCURRING LATE AFTER TREATMENT OF THYROTOXICOSIS WITH RADIOIODINE. Glenn E. Sheline, Stuart Lindsay, Kenneth R. McCormack, and Maurice Galante (Univ. of California, San Francisco). J. Clin. Endocrinol. and Metabolism, 22: 8-18(Jan. 1962).

Among 256 patients with toxic diffuse goiter treated with radioiodine between 1946 and 1953, there were 8 patients in whom thyroid nodules developed between 5 and 14 years after the I^{131} therapy. Thyroidectomy in each of the 8 pa-

tients showed multiple nodules as well as effects attributable to irradiation. The frequency of occurrence of the late nodules was much higher in the younger patients, the highest frequency being in those less than 20 years of age at the time of treatment. These nodules appeared to originate in hyperplastic regenerating areas of thyroid epithelium and were thought to be due to a stimulatory effect of thyrotropin acting on thyroid tissue still capable of proliferating despite injury by irradiation. Development of the thyroid nodules or adenomas in the 8 patients closely paralleled the development of nodules as described in irradiated rat thyroids. Except for a single invasive adenoma in 1 patient, there was no evidence of malignancy in these human thyroid glands. (auth)

6332 FAILURE OF BONE MARROW TO INTERFERE WITH THE AUGMENTATION OF X-RAY LEUKEMOGENESIS BY URETHAN. I. Berenblum, F. E. Rewald, and N. Trainin (Weizmann Inst. of Science, Rehovoth, Israel). J. Natl. Cancer Inst., 27: 1361-7(Dec. 1961).

Ten weekly intravenous injections of isologous bone marrow into C57BL/6 mice, each injection following an intraperitoneal injection of urethan, failed to inhibit the augmentation by the urethan of leukemogenesis induced by a previous, single, total-body x irradiation of 400 r. One intravenous injection of bone marrow depressed leukemogenesis by a single dose of 400 r x irradiation without any urethan treatment. These results do not support the possibility that the urethan effect on leukemogenesis causes a depression of the bone marrow, and thus lend further weight to the idea that its action represents a promoting factor, with irradiation serving essentially as initiating factor, in the relatively low dose ranges used. When bone marrow was injected soon after the irradiation, to inhibit leukemogenesis, and urethan given subsequently, the resulting leukemia incidence was considerably higher than that obtained with irradiation alone, and almost as high as with irradiation, without bone marrow, followed by urethan. It is suggested that the inhibiting effect of normal bone marrow on x irradiation leukemogenesis probably operates at the initiating stage. (auth)

6333 RADIATION RESPONSE OF MAMMALIAN CELLS GROWN IN CULTURE. II. SURVIVAL AND RECOVERY CHARACTERISTICS OF SEVERAL SUBCULTURES OF HeLa S3 CELLS AFTER X IRRADIATION. R. Z. Lockart, Jr., M. M. Elkind, and W. B. Moses (National Cancer Inst., Bethesda, Md.). J. Natl. Cancer Inst., 27: 1393-1404(Dec. 1961).

Three subcultures of HeLa S3 cells, which are of human origin, were studied to determine their response to x rays. The ability of the cells to retain unlimited proliferation was determined by standard tissue-culture techniques for handling single cells. Cells were irradiated with 55 kv x rays delivered at 722 rad per minute. The three subcultures showed characteristic differences in their survival parameters. Two of the subcultures had average mean lethal doses (MLD) near 100 rad, while the third had an average MLD of 131 rad. A range of average extrapolation numbers from 1.4 to 4.9 was observed, and each subculture had a different but characteristic average value. The three subcultures also contained different chromosome complements. It was not possible to correlate either the MLD or the extrapolation number with chromosome complements. In spite of this, surviving cells of all three subcultures were capable of repairing sublethal damage starting immediately after x irradiation. Repeated recovery cycles were also demonstrable when sufficient lengths of time were allowed between doses. In addition to recovery, increases in the MLD of recovered cells in some instances caused the net survival obtained after a given total dose of x rays to be considerably greater when the same total dose was fractionated. (auth)

6334 TESTING OF THE SENSE CAPACITIES IN THEIR SIGNIFICANCE FOR RADIATION BIOLOGY AND RADIO PATHOLOGY — COMPARISON OF THE EFFECT OF SINGLE AND SERIES CURRENT PULSES. G. Sitzlack and E. von Skramlik. Kernenergie, 4: 701-6(Sept. 1961). (In German)

A comparison of the effects of single and series pulse x irradiations on threshold amplitudes was made for the sensations of shock or prickling (which is related to the pressure sense) and of puncture and intolerable pain. A pulse current of 50 or 1000 cycles/sec was used. It was established that for all body sites (with the exception of the tooth) the threshold for prickling was lowest in the 50 cycle series. It is markedly lower than the threshold for shock sensation with a single pulse and also lower than the threshold for prickling with 1000-cycle pulses. Under all conditions the amplitude for the shock or prickling sensation is lower than for pain sensation. The threshold for various types of irritation depends on the body site. (J.S.R.)

6335 THE EFFECT OF NICOTINIC ACID AMIDES ON THE RADIATION SENSITIVITY OF TUMOR CELLS AND WHOLE-BODY X-IRRADIATED MICE. R. Koch and I. Seiter (Universität, Freiburg i. B.). Naturwissenschaften, 48: 626-7(1961). (In German)

Along with the H_2O_2-induced inhibition of glycolysis, there is a decrease of the DPN concentration, which the addition of nicotinic acid amide normalizes. A study was made to determine if the amide, on this basis, represents a radiation protective substance both for tumor and tissue cells. The addition of nicotinic acid to suspensions of Ehrlich ascites before irradiation of the suspension gives a protective effect corresponding to the protection given by cysteamine or serotonin. A corresponding study was made to determine if nicotinic acid amide offered a protective effect for mammals. The amide was injected into mice before irradiation. The results showed that the nicotinic acid amide gave radiation protection to tumor cells, but not to normal tissue. (J.S.R.)

6336 THE EFFECT OF SMALL RADIATION DOSES ON PLANT GROWTH. Adalbert Suess (Bayerische Landesanstalt für Pflanzenbau und Pflanzenschutz, Munich). Naturwissenschaften, 48: 650(1961). (In German)

The effects of radiation doses from 0 to 800 rad on the seed of summer barley and wheat were studied. The seeds were irradiated in the Munich Research Reactor at a dose output of 20 rad/min. The sprout length was used as a measurement of the growth of the germinating seeds. The results are tabulated for summer barley for the 1959 and 1960 harvests and show a considerable growth acceleration after 7 days in the dose range from 2 to 40 rad. In summer wheat the growth acceleration was less pronounced. (J.S.R.)

6337 IRON UTILIZATION AND RADIATION EFFECTS. ANIMAL EXPERIMENTAL PRELIMINARY INVESTIGATIONS. Bruno Choné (Universität, Heidelberg, Ger.). Nuclear-Med., 2: 21-34(1961). (In German)

Experimental investigations are described of iron utilization in rats subjected to whole body irradiation with a Co^{60} unit. Particular attention was paid to the first signs of a disturbance in iron incorporation. The observed "threshold dose" was 25 to 50 r. A more definite change in the shape of the curves was seen from 100 r onwards. The rate of iron incorporation into red cells was related to the pe-

riod between irradiation and Fe^{59} administration (latency of 2 to 5 days). The results of measurements on blood samples are compared with autoradiographic findings on bone marrow, liver, and spleen specimens. (auth)

6338 SIX CASES OF LEUKAEMIA AFTER IRRADIATION. S. Plesničar, S. Modic, and B. Cernelč (Medical Faculty, Oncological Inst., Ljubljana, Yugoslavia and General Hospital, Maribor, Yugoslavia). Nuclear-Med., 2: 80-6(1961). (In English)

Six cases of leukemia in patients exposed to x rays are described. Clinical course and blood values are given. All known details are submitted, since it is extremely important to gather all relevant information in cases of this kind. (auth)

6339 EFFECTS OF SELECTIVE ULTRAVIOLET IRRADIATION OF THE NUCLEI OF LIVING CELLS. P. O'B. Montgomery, F. Van Orden, L. L. Hundley, C. L. Chapman, and J. E. Cook (Univ. of Texas Southwestern Medical School, Dallas). Proc. Soc. Exptl. Biol. Med., 108: 372-5(Nov. 1961).

Continuous ultraviolet irradiation of the nucleus of a living cell produces nuclear damage. Although this damage resembles nuclear damage which occurs when the entire cell is irradiated, it is less severe due to the protection of the cytoplasm from the effects of irradiation. Continuous ultraviolet irradiation of the nucleus of a living cell produces cytoplasmic damage resembling that which occurs when the entire cell is irradiated, but is less pronounced. (auth)

6340 IMMUNE RESPONSE IN IRRADIATED MICE WITH PEYER'S PATCH SHIELDING. Leon O. Jacobson, Edna K. Marks, Eric L. Simmons, and Evelyn O. Gaston (Argonne Cancer Research Hospital, Chicago). Proc. Soc. Exptl. Biol. Med., 108: 487-93(Nov. 1961).

Shielding one Peyer's patch of a mouse during lethal x irradiation protects a sufficient number of cells to cause rejection of a heterologous or homologous bone marrow graft. Shielding 11 mm of the small intestine results in a similar but less violent reaction. A dosage of 650 r or more to the protected Peyer's patch is necessary to impair the capacity of the lymphatic tissue to reject the graft. Regeneration of lymphatic tissue is evident in the spleen, mesenteric lymph node and thymus in Peyer's patch-shielded mice 6 days post-irradiation. On the other hand no bone marrow regeneration was observed nor was there evidence of granulocytic, megakaryocytic, or erythrocytic regeneration elsewhere. (auth)

6341 BEHAVIOR OF MAMMARY TUMOR TRANSPLANTS OF RATS IN TISSUES PREVIOUSLY IRRADIATED. A. Corinaldesi (Università, Bologna). Radiobiol. radioterap. e fis. med., (3) 16: 157-67[1961]. (In Italian)

The clinical histological modality of the attachment and development of mammary tumor transplants of rats in tissues preirradiated with single and fractional doses of the same value was analyzed. The right axillary region of 50 animals was irradiated with single and fractionated doses and then a suspension of tumor cells in physiological solution at 25% was injected. The results obtained, relative to the number of attached tumor transplants, their increase, and the histological evidence show that in previously irradiated tissue, either with a single dose or with fractionated doses, with a threshold dose of 3000 rad, the mammary tumor transplants find conditions difficult for attachment and development. (tr-auth)

6342 EFFECT OF HIBERNATION ON THE MODIFICATIONS PROVOKED BY X RAYS IN THE BASIC SUBSTANCE OF JOINTS. STUDY OF THE DIFFUSIBILITY OF LIQUIDS WITH THE RADIOGRAPHIC METHOD. A. Cavina Pratesi, G. R. Bandirali, and C. Moia (Università, Pavia, Italy). Radiobiol. radioterap. e fis. med., (3) 16: 168-81 [1961]. (In Italian)

The radiographic method was used to study the phenomenon of the diffusion of liquids in the skin of hibernating animals exposed to radiation at doses of 500 and 1000 r, administered on the abdominal quadrant. The results show that in hibernation a sharp decrease of the diffusion occurs. The absorption velocity of the substance used as index does not show any clear difference proportional to the dose administered, which is found in animals irradiated while awake. A decrease of the radiation effect is not deduced, and the possible mechanism of the phenomenon is discussed. (tr-auth)

6343 THE INACTIVATING EFFECTS OF X-RAYS AND INCORPORATED RADIOACTIVE PHOSPHORUS AND THEIR MODIFICATION BY OXYGEN AND OTHER SUBSTANCES. James C. Van Dyke (Sloan-Kettering Inst. for Cancer Research, New York and Cornell Univ. Medical Coll., New York). Radiology, 78: 91-9(Jan. 1962).

It is proposed that the inactivation of cells or virus by x-irradiation is caused by an energy-absorbing event in the immediate vicinity of the phosphate linkage of the DNA, possibly in the phosphorus atom itself as it has the largest number of electrons, leaving the DNA in a reactive, excited state. The manner in which the energy of this excited DNA is dissipated determines whether or not one or more of the bonds of the phosphate linkage is broken. The probability that such strand breaks are lethal depends on the number of strands which must be broken (in one compound event, owing to the exponential nature of the survival curves) in order to break the "molecule" in two. If two such molecules must be broken to produce a lethal effect, then the survival curve will be "two hit." It is proposed that the oxygen effect is due to a direct interaction of molecular oxygen with the reactive DNA, blocking a restoration which can take place only in the presence of certain substances. Evidence cited to support the theory presented includes the oxygen effects on intracellular bacteriophage and on the inactivation efficiency of incorporated radioactive phosphorus. Some of the predictions which the theory affords are enumerated. (auth)

6344 A STUDY ON THE RADIOSENSITIVITY OF MOUSE DURING VARIOUS PHASES OF THE OESTROUS CYCLE. Siu-choun Ma (Inst. of Biophysics, Academy of Sciences). Sci. Sinica (Peking), 10: 860-6(Nov. 1961). (In English)

Radiosensitivity during various phases of the oestrous cycle was studied in 251 white virgin mice of the Kunming strain. Results show that radiosensitivity during different phases of the oestrous cycle is not identical as determined by the survival rate, average survival time, and average body weight in a period of 30 days after x-irradiation. Those in pre-oestrus and oestrus are more radioresistant; those in di-oestrus, more radiosensitive; and those in post-oestrus, intermediate between the two. The different concentrations of estrogen in the blood are considered to be one of the factors which cause the difference in radiosensitivity. (auth)

6345 METABOLISM OF GLYCOGEN IN SKIN AND THE EFFECT OF RADIATION. Kenji Adachi, Donald C. Chow, and Stephen Rothman (Univ. of Chicago). Science, 135: 216-17(Jan. 19, 1962).

Continuous biosynthesis of glycogen was demonstrated by perfusion of the skin of dogs with uniformly labeled C^{14}-glucose. If the skin is irradiated in vivo with an erythemal

dose of x-rays 24 hours prior to perfusion, the uptake of radioactive glucose into glycogen is significantly increased. The irradiation effect appears to be due to enzymatic dysbalance. (auth)

6346 THE EARLY EFFECT OF IONIZING RADIATION (Co^{60}) ON THE HUMAN BRAIN. Dennes Afra, Wilhelm Mueller, and Ortwin Wilcke (Max-Planck-Institut für Hirnforschung, Cologne and Neurochirurgische Universitäts-klinik, Cologne). Strahlentherapie, 116: 231-41(Oct. 1961). (In German)

A study of 11 human brains after tumor surgery, followed by local radio-cobalt bead therapy, and a survival time of 6 hours to 6 weeks is reported. The radiation doses were 10800 r and 5400 r. Macroscopic investigations of the brains showed mass displacements, compression signs, and a considerable edema. The histologic results allow the following conclusions: A necrosis of all kinds of tissue can be expected at a radiation dose of 5000 to 10000 r. The tissue damage is completed after 17 days at a dose of 5000 r, and after 4 days at a dose of 10000 r. The maximum width of the necrotic area is about 4 to 6 mm at 5400 r, and about 10 to 12 mm at 10800 r. A localization of the necrosis by connective tissue occurs after 6 weeks. There are no radiation changes at doses below 5000 r single irradiation. This can be said, with certainty, by determination of the isodose curves and by transferring them to the tissue. The results obtained after use of ionizing radiation on the human brain, described as "early changes," are compared with experimental data in the literature. A general agreement has been found. (auth)

6347 DETECTION OF THE BIOLOGICAL EFFECTIVENESS OF WEAK RADIATION BY MEANS OF A LEUKOCYTE TEST. Otto Henn and Eugen Olbrich (Universität, Innsbruck, Austria and Forschungsinstitut, Osterreichesche Akademie der Wissenschaften, Gastein). Strahlentherapie, 116: 267-74(Oct. 1961). (In German)

In-bred mice were exposed to the action of radiation emanation for 10 or 24 days. The results of the tests carried out under biometric criteria are essentially identical with earlier test results. Therewith the so-called leucocyte test (lymphocyte decrease, granulocyte increase) turns out to be a useful test for the evidence of biological action of weak prolonged radiation. Especially suitable to this may be a function of the kind of the value T. (auth)

6348 ISOTOPE NEPHOGRAPHY AS DIAGNOSTIC METHOD FOR RADIOTHERAPISTS. Karl zum Winkel, Josef Becker, and Kurt E. Scheer (Universität, Heidelberg, Ger.). Strahlentherapie, 116: 489-501(Dec. 1961). (In German)

The advantages of the isotope-nephrography are described after a detailed representation of the technique and of the clinical performance of the method. The diagnostic results of the isotope-nephrography obtained in 461 patients with tumors of the abdomen are reported. The results of the method are compared with the data of the excretion-urography in 187 patients. The results of 127 control examinations are discussed. The isotope-nephrography is recommended as a routine method before, during, and after radiation therapy for all patients with tumors of the abdomen. (auth)

6349 KIDNEY CHANGES IN WHOLE-BODY IRRADIATED SWINE. Max Nuessel and Josef Schuck (Bundesamt fur Zivilen Bevölkerungsschutz, Bad Godesberg, Ger.). Strahlentherapie, 116: 502-22(Dec. 1961). (In German)

Morphological kidney examinations of whole-body irradiated swine showed, during the acute state of the radiation syndrome, more or less serious degenerative changes, resembling an acute tubulonecrosis. Surviving animals showed distinct nephroscleroses 4 to 6 months after irradiation with 800 to 1000 r. The pathogenesis and course of the observed kidney changes are discussed. (auth)

6350 LONGTERM RESULTS OF STEREOTACTIC RADIOISOTOPE IRRADIATION OF HYPOPHYSEAL TUMORS. Fritz Mundinger (Universitäts-klinik, Fieburg i. B.). Strahlentherapie, 116: 523-35(Dec. 1961). (In German)

Primary and, especially, the secondary stereotactic irradiation of an adenoma of the hypophysis is significantly superior to surgical therapy alone as proven by long-term investigations in 108 cases. This superiority is reflected by the operative mortality, which is 0 of 1.6%, as well as by the survival rate and the incidence of recurrence. The rate of improvement of vision is better for 26 to 44% of the patients and that of the visual fields for 17 to 29% in comparison to an open operation alone. The late radiation damages of the chiasma and the optic nerve, which are difficult to distinguish from tumor-recurrences, are a problem which still is not solved satisfactorily. (auth)

6351 STUDIES OF THE NON-SPECIFIC REACTION OF ORGANISMS TO RADIATION INJURY AND TUMOR PATIENTS. Friedhelm Hess (Universität, Marburg/Lahn, Ger.). Strahlentherapie, 116: 536-49(Dec. 1961). (In German)

The phagocytic activity of blood granulocytes is important for nonspecific defense reactions. Stimulation of the phagocytosis even occurs under the influence of the radiation syndrome after whole-body irradiation or under the influence of tumors. This result was obtained by investigations on tumorous rats irradiated with x rays, as well as by examinations of tumorous patients. Values of the phagocytosis, which were increased above the average indicate a progressive tumor growth during the course of the disease. (auth)

6352 RADIOBIOLOGICAL STUDIES OF SIEVE AND GRID IRRADIATION. [PART] 2. EXPERIMENTAL ANIMAL STUDIES ON THE IMPORTANCE OF TIME FACTORS FOR THE SKIN PROTECTIVE EFFECT OF SIEVE IRRADIATION. Ludwig Rausch (Universität, Marbourg/Lahn, Ger.). Strahlentherapie, 116: 593-609(Dec. 1961). (In German)

In experimental studies on the radiobiology of sieve irradiation the time factor (fractionation and protraction) as a second phenomenon is investigated as to its importance for skin protection. After a critical discussion of the relevance of the results obtained with the perforation-hole healing test on the rabbits ear (within the first few hours after irradiation the repair of radiation injuries occurs faster in the uninjured tissue, than in the mechanically traumatisized tissue), it is shown that there is a fractionation factor, also, for sieve irradiation. Using these results, the fractionation patterns used in the common clinical grid therapy are discussed; and it is shown that, especially for the protected volumes, a considerable increase in tolerance in contrast to the common series using homogenous fields is explained by the time-fractionation patterns. (auth)

6353 CHANGES IN SERUM PROTEINS IN THE GOAT AFTER IRRADIATION. PART II. THE EFFECT OF IRRADIATION ON SERUM PROTEINS. Ernst Waldschmidt-Leitz, and Lorenz Keller (Heiligenberg-Instituts, Heiligenberg/Baden, Ger.). Strahlentherapie, 116: 610-14(Dec. 1961). (In German)

A decrease in the albumin portion and the increase in the globulin-portions of the serum of goats appear after irradiation. At the same time changes in the amino acid compo-

sition of the β-globulin-fraction occur. This results, among other things, in an almost complete disappearance of sulphur containing groups and in an increase of histidine and lysine. Cystine is oxidized in the peptid-stage. (auth)

6354 THE EFFECT OF DIFFERENT CARBOHYDRATE SOURCES AND THE OSMOTIC RATIOS ON THE RADIATION SENSITIVITY OF CELLS OF SACCHAROMYCES CEREVISIAE. Etta Greve (Universität, Freiburg i. B.). Z. Naturforsch., 16b: 589-97(Sept. 1961). (In German)

The reason for the radio-protective effect of glucose was sought. In a first series of experiments the effect of arabinose and pyruvic acid was compared with the effect of glucose, keeping the molarity on the same level with all three substances. Preliminary experiments indicated that neither arabinose nor pyruvic acid is metabolized. Nevertheless the pyruvic acid proved to be as effective in radio-protections as glucose, whereas arabinose showed less protective effect. As pyruvic acid has no hydroxyl groups and only little structural similarity to glucose, this result is inconsistent with a direct radio-protective effect of the glucose molecule. In addition these experiments show that neither the energy production nor any of the connected reactions are responsible for the radio-protective effect of glucose. Thus the only explanation left is that the changed osmotic pressure influences the radio-sensitivity. For further proof experiments with different glucose concentrations in the irradiation medium were performed. As expected they showed that the radiation damage was enhanced with decreasing glucose concentration, with the highest sensitivity reached in a medium of 4% glucose concentration. After having learned about the significance of the osmotic pressure in the irradiation medium, the possibility that the difference in the osmotic pressure of the preceding culture medium and the irradiation medium enhances the radiosensitivity was examined. Keeping the concentration of the irradiation medium of the same level, the glucose concentration of the culture medium was changed. This experiment showed that the radiosensitivity of the yeast cells is not influenced by the difference in the osmotic pressure of culture medium and irradiation medium. But on the other hand, it was shown that the osmotic pressure of the culture medium also has an influence on the radio-sensitivity of yeast cells comparable to that of the irradiation medium. In a further experiment the effect of two entirely different culture media, namely beerwort and a half-synthetic medium, was compared. It was found that there must be a special radioprotective substance in the beerwort besides the glucose, which extends its effect up to the time of irradiation. (auth)

6355 THE EFFECT OF AN IRRADIATION DURING THE GROWTH PHASE ON THE DEVELOPMENT OF EUCOCCIDIUM DINOPHILI. E. Stoessel-Muegge (Technische Hochschule, Darmstadt, Ger.). Z. Naturforsch., 16b: 598-604(Sept. 1961). (In German)

The growth phase of Eucoccidium dinophili, during which the sporozoites develop into germinating gamonts, was subdivided into five well-defined development periods (growth stages of the size dimensions I-V). The individual stages were irradiated with 400, 800, 1200, and 1600 r. The radiation damages were first visible in the nuclear division of sporogony. The radiation sensitivity was determined as the percentage of damaged oocysts. In order to prevent measurement errors, the percentage of the spontaneous nuclear division damages and the injury to the parasites by irradiation of the hosts were considered, and it was assumed that macrogametes only develop parthenogenetically. The studies showed a greater radiation sensitivity for the early growth stages. The variation of the radiation sensitivity at the beginning of the growth phase is much greater in an irradiation of 400 r than in an irradiation with higher doses. At the end of the growth phase the radiation sensitivity remains constant or increases somewhat. Infection studies with spores which seem normal under usual living conditions, but which originate from greatly radiation damaged oocysts, show that some of these spores are still capable of infection and development; however degeneration phenomena appear during sporogony. In Eucoccidium dinophili occasionally a late manifestation of radiation damage will appear. (tr-auth)

Radiation Sickness

6356 (UCLA-495) STRUCTURE ACTION RELATIONSHIPS IN RADIOPROTECTANT COMPOUNDS: AMINES AND AMINE OXIDES. Thomas J. Haley, A. M. Flesher, and L. Mavis (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology). Nov. 27, 1961. Contract AT(04-1)-Gen-12. 22p.

The radioprotectant activity of 204 compounds is investigated. The relationships between various substituent groups on a variety of organic molecules, both amines and amine oxides, and their effects on radioprotectant activity are discussed. The most active compounds were: quinoline-1-oxide; Amodiaquin; Amodiaquin 1-oxide; isonicotinic acid-1-oxide; ethyl nicotinate-1-oxide; N-ethyl nicotinamide-1-oxide; isocinchomeronic acid; and Quinacine-N^{10}-10-dioxide. All of these compounds, except Amodiaquin and isocinchomeronic acid, has the postulated $-N=C-$ (O above) structure required for radioprotectant activity. However, some compounds with the required structure were inactive, probably due to either blocking the active 2,3 positions, non-absorption from the intestinal tract, inability to penetrate into the cells and protect cellular elements essential for survival or too rapid a rate of excretion or a combination of all four factors. None of the above compounds approached mercaptoethylamine or the mercaptoalkylisothiouronium compounds in radioprotectant activity. (auth)

6357 CUTANEOUS RADIOPROTECTION OF THE RAT BY METHYLENE BLUE, DINITROPHENOL, AND AMINOTHIAZOL. Jean Loiseleur, Liliane Catinot, and Annick de Vomécourt. Compt. rend., 253: 1624-6(Oct. 9, 1961). (In French)

The simultaneous injection of methylene blue, dinitrophenol, and aminothiazol allows the cutaneous radioprotection of the rat. This treatment increases glycolysis and inhibits proteic synthesis. The nucleoproteins thus lose momentarily the fragile structure connected to their synthetic activity and are introduced into a "non-organization" state, characterized by a decreased radiosensitivity. (tr-auth)

6358 THE QUESTION OF THE EFFECTIVENESS OF CELL-FREE SPLEEN EXTRACT IN THE TREATMENT OF RADIATION SICKNESS. Jana Šlotová and Z. Karpfel (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Folia Biol. (Prague), 7: 412-14(1961). (In English)

Ellinger's results in using spleen extract to treat radiation sickness in mice were verified. It was found that Ellinger's spleen extract stimulates mitotic activity in irradiated bone marrow if administration is commenced immediately or 24 hours after irradiation. In this respect the extract acts as a nonspecific stimulus. The extract does not positively influence mortality and in some cases tends to hasten death. (auth)

6359 CRITICALITY ACCIDENTS IN VINCA, YUGOSLAVIA, AND OAK RIDGE, TENNESSEE. COMPARISON OF RADIATION INJURIES AND RESULTS OF THERAPY. Gould A. Andrews (Oak Ridge Inst. of Nuclear Studies, Inc., Tenn.). J. Am. Med. Assoc., 179: 191-7(Jan. 20, 1962).

Major accidents involving radiation from nuclear reactors occurred in Oak Ridge, Tenn., and in Vinca, Yugoslavia, in 1958. The 2 accidents were in some ways similar, and both contributed information on the treatment of total-body radiation injury. After the Y-12 accident at Oak Ridge, the 5 exposed men recovered with supportive care. The 6 Yugoslavian radiation victims were moved to Paris, where 1 died, and 5, including 4 who had received bone-marrow injections, recovered. Efforts to evaluate the significance of the marrow treatment have involved consideration of physical measurements of radiation dose, biological evidence of severity of injury, and evidence for and against success of the marrow graft, but have not proved its value in these cases. A comparison of the 2 accidents helps to give perspective on these problems. (auth)

6360 MODIFICATION OF THE RADIO-INDUCED MUTABILITY IN DROSOPHILA BY 2,4-DINITROPHENOL. Hedi Fritz-Niggli (Universität, Zurich). Naturwissenschaften, 48: 650-1(1961). (In German)

The variability of the radioinduced mutation rate with the age or development state of the germs cells can be used as an indication of a dependence of the mutation genesis on the intracellular metabolism of the cells. Therefore the effect of 2,4-dinitrophenol on the mutation rate of Drosophila melanogaster was investigated. The results established that treatment with this chemical before irradiation diminished drastically (approximately fourfold) the number of radioinduced recessive lethal factors and chromosome losses by rupture. (J.S.R.)

6361 INVESTIGATIONS ON A BIOLOGICAL RADIATION PROTECTION. XLIII. THE QUESTION OF THE SEROTONIN DEPENDENCY OF THE RADIATION PROTECTION EFFECT OF RESERPIN. Hans-Joachim Melching, Roland Jacques, and Hans-Adolf Ladner (Universität, Freiburg i. B.). Strahlentherapie, 116: 251-8 (Oct. 1961). (In German)

It is shown that the protective effect exerted by either reserpine or serotonin in mice receiving lethal x irradiation may be augmented or antagonized by substances of varying pharmacological character. (auth)

6362 THE EFFECT OF THE TIME SPAN BETWEEN SPLEEN EXTIRPATION AND WHOLE-BODY IRRADIATION ON THE RADIATION SYNDROME OF THE MOUSE. Raimund Fridrich (Röntgendiagnostische Zentralinstituts, Zurich and Kantonsspitals, Zurich). Strahlentherapie, 116: 259-66(Oct. 1961). (In German)

A dependence of the time interval between operation and subsequent whole body irradiation on the mean survival time of male mice could be shown. The kind of the operation was unimportant. The splenectomized animals show the same reaction as the omentectomized animals. If irradiation is done during the first 48 hours after the operation, then there is an increase of the survival time. The experimental results were explained by the "crossed resistance theory" of Selye's "common adaptation syndromes." (auth)

6363 THE RELATIVE PROTECTIVE EFFECT OF PYRIDOXINE, p-AMINOBENZOIC ACID, AND VARIOUS CYSTEAMINE DERIVATIVES ON THE X-RAY INDUCED DEGRADATION OF PYRIDOXAL-5-PHOSPHATE. Karl F. Nakken (Norwegian Radium Hospital, Montebello, Norway). Strahlentherapie, 116: 628-37(Dec. 1961). (In English)

The relative rate of radical inactivation by p-aminobenzoic acid, pyridoxine, 2-mercaptoethylguanidine, N-dimethylcysteamine, N-(2-mercaptoethyl)-piperidine, and N-dibutylcysteamine have been studied in a two-solute system with pyridoxal-5-phosphate as indicator of radiation damage. The protection indices of these compounds were found to be 3.1 (extrapolated to zero concentration of the indicator), 1.3, 1.2, 0.8, 0.6, and 0.5, respectively. When the concentration of the indicator was increased from 9×10^{-5} M to 2.1×10^{-4} M, the protection index of p-aminobenzoic acid decreased from 2.3 to 1.4, thus giving evidence of energy transfer from p-aminobenzoic acid to the indicator. The lack of correlation between radical scavenging effect in vitro and the ability of the compounds to exert radioprotection in vivo, suggests that this effect in vivo is largely dependent on biochemical factors. (auth)

CHEMISTRY

General and Miscellaneous

6364 (JPRS-10613(Pt.II)) U.S.S.R. CHEMICAL INDUSTRY. A. P. Vinogradov, ed. Translation of Khimicheskaya Promyshlennost' S.S.S.R., Moscow, July 1959, p.381-408. 226p.

Ten papers are included which treat various aspects of Russian chemical industry, e.g., fertilizers, sulfuric acid, soda, chlorine, and catalysis. A separate abstract was prepared for one paper which deals with isotope production. (D.L.C.)

6365 (JPRS-10613(Pt.II) (p.409-40)) PREPARATION OF RADIOACTIVE AND STABLE ISOTOPES. A NEW DOMAIN OF CHEMICAL TECHNOLOGY. Yu. S. Frolov, V. V. Bochkarev, I. F. Tupitsyn, and R. L. Globus. (Translation).

The various applications of radioisotopes in industry and the development of nuclear industry in Russia are outlined briefly. Modern methods used for the preparation of isotopes and chemical compounds containing radioisotopes and stable isotopes are discussed in detail. (D.L.C.)

Analytical Procedures

6366 (NEPA-940) METHODS FOR THE ANALYSIS OF BERYLLIUM CARBIDE. W. L. Bridges, Earl S. Funston, and Sherman A. Reed (Fairchild Engine and Airplane Corp. NEPA Div., Oak Ridge, Tenn.). Mar. 21, 1949. Contract [W-33-08-ac-14801(16250)]. 24p.

Analytical methods are given for determining the composition and impurities of beryllium carbide. A summary of the experimental work leading to these procedures and supporting data are also presented. Analytical procedures for the determination of free and combined carbon, moisture, nitrogen, beryllium oxide, silica, iron, total beryllium, and beryllium metal are outlined. Diagrams of special apparatus used are included. (auth)

6367 (PG-Report-236) THE DETERMINATION OF URANIUM IN PLUTONIUM METAL, PLUTONIUM COMPOUNDS AND NITRIC ACID OR HYDROCHLORIC ACID SOLUTIONS OF PLUTONIUM (POLAROGRAPHIC (METHOD). (United Kingdom Atomic Energy Authority. Production Group, Windscale, Sellafield, England). 1961. 6p.

An alternating-current polarographic method is described for the determination of U in Pu metal, Pu compounds, and solutions of Pu in HNO_3 or HCl. The U is estimated in trivalent Pu solution in $HClO_3$ with a limit of detection of 1 μg U in a concentration range of 10 to 200 ppm U. Interfering elements are Mo, Cu, and Np. (T.R.H.)

6368 (TID-14330) DETERMINATION OF THE MOISTURE CONTENT OF PHARMACEUTICALS USING RADIOISOTOPE TECHNIQUES. Wayne V. Kessler and John E. Christian (Purdue Univ., Lafayette, Ind.). June 30, 1961. Contract AT(11-1)-737. 7p.

The feasibility of determining the moisture content of drug products using the radiation absorption technique was ascertained. The penetration of ionizing radiation through samples of calcium carbonate with known moisture contents was measured. Preliminary experimentation showed that the sample layer must be as uniformly dense as possible in order to get reproducible results. It was concluded that a linear relationship exists between the penetration of beta particles from a SrY^{90} source and the moisture content of calcium carbonate. The data indicate that the ionizing radiation absorption technique can be used to determine the moisture content of calcium carbonate samples. (P.C.H.)

6369 (TID-14433) ATMOSPHERIC TRITIUM ANALYSIS. Technical Progress Report No. 3. Earl W. Barrett and Leonid Huebner (Chicago, Univ.). Nov. 27, 1961. Contract AT(11-1)-636. 65p.

The sequence of measurements of tritium in Chicago precipitation was extended into the winter of 1960 and 1961. Precipitation sampling was augmented near the end of the period by samples of water vapor condensed directly from the ambient surface air by means of mechanical refrigeration equipment. The tritium contents of such condensed vapor samples agreed to within the standard error of the measuring technique with the tritium contents of simultaneously-occurring precipitation. This observation, if verified by further data, indicated that the rate of tritium equilibration between falling precipitation and ambient water vapor is fairly rapid. The continuous sequence of tritium data, when smoothed by taking 100-day running means, showed an asymptotic decay superimposed upon an annually-periodic cycle with peaks in the early spring. The first study assumed a two-reservoir model of the atmosphere; the stratospheric reservoir discharges into the troposphere with a rate coefficient which is a periodic function of time with a spring maximum, while the troposphere discharges into the hydrospheric sink with a constant rate coefficient. The rate coefficient for the troposphere was found to be 17.4, corresponding to a mean residence time for water vapor of 21 days. The periodically varying stratospheric storage time was found to have a spring-minimum effective value of 0.42 year, or 153 days, and an autumn maximum of 3.28 years. The annual-mean value for this residence time is 1.17 years. The model gave an excellent fit with the smoothed data for the first year; systematic deviations appeared during the second. These deviations were explainable by the assumption of two stratospheric reservoirs, a low-latitude reservoir with a storage time long compared to one year and a high-latitude reservoir with the storage time as given above. It was found, on the basis of the calculated parameters of the two-reservoir model, and on the assumption of a mean value of 3 cm for the tropospheric precipitable water, that the total tritium content of the stratosphere at the beginning of November 1958 was 27.6 kg while that of the troposphere was 255 gm. The stratospheric burden was reduced to 1.66 kg by the end of October 1960 by transport to the troposphere and radioactive decay. The annual-mean rate of exchange of water vapor across the tropopause by all processes was calculated to be 7.6×10^{-3} cm of precipitable water. It seemed likely that only a small fraction of the water vapor in the stratosphere enters as vapor in tropical latitudes; most of the water vapor is transported toward high latitudes by eddy-exchange in the troposphere and enters the stratosphere by eddy-mixing processes north of the subtropical high-pressure belt. An attempt to deduce the parameters of a three-reservoir model through application of the method of least squares is described. Two trials of the problem on an IBM 704 computer failed to converge after 69 and 20 iterations, respectively. It is believed that the slowness of convergence was the result of a set of poor first estimate of the parameters. (auth)

6370 (TID-14465) POLAROGRAPHIC AND VOLTAMETRIC DETERMINATION OF PURINES AND PYRIMIDINES. ANALYSIS OF MIXTURES. Report No. 66. David L. Smith and Philip J. Elving (Michigan. Univ., Ann Arbor). Sept. 15, 1961. Contract AT(11-1)-70. 34p.

The analytical significance and applicability is discussed of the polarographic and voltametric behavior at the dropping mercury electrode and at the stationary graphite electrode of purine and pyrimidine, and of a number of their derivatives, including those of biological and medicinal importance. The conditions are outlined under which one purine or pyrimidine can be determined in the presence of related compounds. To illustrate the possible analysis of mixtures, a procedure is given for the determination of the three most important nucleic acid components, i.e., adenine, cytosine and guanine, in the presence of each other. The qualitative potentialities of the electroactivity of the purines and pyrimidines is indicated, e.g., the identification of the three hydroxy-purines, hypoxanthine, xanthine, and uric acid, in the presence of each other. (auth)

6371 (UCRL-6487) A FEASIBILITY STUDY OF A METHOD TO ANALYZE THE MOON'S SURFACE USING NUCLEAR INELASTIC SCATTERING (thesis). Robert J. Stinner (California. Univ., Livermore. Lawrence Radiation Lab.). May 12, 1961. Contract W-7405-eng-48. 46p.

A selenological study by the Jet Propulsion Laboratory shows that the following elements could possibly be found in abundance on the moon: Fe, Si, Mg, Al, O, K, Na, Ca, and Ni. An investigation was made to determine if the gamma rays produced by de-excitation of these nuclei, after the inelastic scattering of 14-Mev neutrons, could be used to determine the minimum abundance of various elements in a typical geological matrix. The conclusion is drawn that less than 1% by atom of Fe, Si, Mg, and Ni, and less than 4% of the remaining elements could be measured. Inelastic (n,n') spectra are shown for each pure element, and some excited state transitions not previously reported are suggested. (auth)

6372 (AEC-tr-4975) RADIOCHEMICAL DETERMINATION OF CESIUM BY COLORIMETRY OF THE DIPICRYLAMINE. A. M. Lefevre, J. F. Lefevre, and A. Raggenbass. Translated by Myra S. Feldman (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.) from J. Inorg. & Nuclear Chem., 12: 297-303(1960). 7p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 13703.

6373 NEW (PHOTOGRAPHIC) METHOD FOR DETERMINING α-ACTIVE ELEMENTS IN SOLUTIONS. M. Nikolae (Institutul de Fizica Atomica, Academia R. P. R., Bucharest). Acad. rép. populaire Roumaine, Rev. phys., 6: 127-37(1961). (In Russian)

The method is used for determining small quantities of α-active elements in solutions without interference from the direct contact of the solution with photoemulsion. The sensitivity of the method is up to 1.5×10^{-12} c/ml of solution (4×10^{-4} g/cm^3 of solution), which is much higher than chemical or radiometric methods using Geiger-Mueller counters. The suggested method is efficient for determining radioactive minerals in water and uranium and thorium in radioactive coal ash. (R.V.J.)

6374 ACTIVATION ANALYSIS—APPLICATION POSSIBILITIES IN INDUSTRY AND RESEARCH. Seigfried Niese and Wolfgang Leonhardt (Zentralinstitut für Kernphysik, Kresden-Rossendorf, Ger.). Chem. Tech. (Leipzig), 13: 509-14(Sept. 1961). (In German)

The principles of activation analysis are summarized as an introduction to a survey on the utilization of various radiation sources and the applications of activation analysis. A tabulation of numerous works on the determination of individual elements is given. 201 references. (J.S.R.)

6375 RAPID ASSAY OF TRITIUM-LABELLED SUBSTANCES INSIDE GM GAS COUNTING TUBES. R. Tykva (Czechoslovak Academy of Sciences, Prague). Collection Czechoslov. Chem. Communs., 26: 2463-72(Oct. 1961). (In English)

A relatively simple and rapid method is described for measuring the radioactivity of tritiated substances in the form of acetylene inside GM internal gas counting tubes. A single working line makes it possible to carry out reproducible determinations of relative specific activities of as many as 18 solid samples within 8 hours with an error less than ±3.5% when the standard deviation of counting is ±2%. The arrangement described permits routine determinations of specific activities to be performed in self-quenching counters down to 10^{-5} μc/mmole C_2H_2. (auth)

6376 ON THE CHEMICAL DETERMINATION OF GRAPHITE IN THE PRESENCE OF NONGRAPHITIC CARBON. Paulette Albert (Laboratoire de Recherches, Epinay, France). Compt. rend., 253: 2535-7(Nov. 27, 1961). (In French)

Graphite containing non-graphitic C is agitated in cold concentrated H_2SO_4, in the presence of a small quantity of an oxidizing agent, to form the solid blue acid sulfate of graphite. The effects of the quantity of the oxidizing agent and of the oxidizing time are used to determine the amount of graphite in the sample. Several natural graphites and a 50% graphite-50% (non-graphitic) coke of saccharose mixture are used as samples. (T.F.H.)

6377 THE USE OF ION-EXCHANGE CHROMATOGRAPHY IN THE ACTIVATION ANALYSIS OF MICROIMPURITIES IN SILICA. A. I. Kalinin, R. A. Kuznetsov, V. V. Moiseev, and A. N. Murin (Inst. of the Chemistry of Silicates, Academy of Sciences, USSR and Leningrad State Univ.). Doklady Akad. Nauk S.S.S.R., 141: 98-100(Nov. 1, 1961). (In Russian)

The silica sample and several standards of various elements were irradiated simultaneously in a reactor. Various inert carriers (10 μg of each element) were added to the silica sample after irradiation. The silica sample was decomposed in a mixture of HNO_3 and HF, and evaporated several times almost to dryness with an HF excess. The HF solution containing the induced activities was then passed through the fluoride form of the strongly-basic anion exchanger AV-17 (8 to 10% cross-linked with divinylbenzene, grain size 30 to 40 μ, height of column 5 cm, diameter of column 2 mm). The elements Cu(II), Co(II), In(III), Ga(III), Zn(II), Cd(II), and Hg(II) are not absorbed by the anion exchange in the fluoride form and pass through the column. The mixture of these elements is converted to chlorides, and the elements are separated by eluting with various concentrations of HCl from an anion exchanger in the chloride form according to the scheme proposed by Kraus and Nelson. The elements forming negative fluoride complexes that are absorbed on the AV-17 anion exchanger in the fluoride form are Sn(IV), Mo(VI), W(VI), As(V), Ta(V), Sb(V), and Au(III). The As, W, Mo, and Sn are eluted together with 17 N HF, and are then separated on a AV-17 anion exchanger in the chloride form, from which the As is first eluted with 11.6 N HCl, the W with 8 N HCl + 1 N HF, the Mo with 1 N HCl and the Sn with 2 N HCl + 3 N HF. Then, the element Ta is eluted from the fluoride anion exchanger with 1 N HF + 2 N NH_4NO_3. Antimony is eluted with 3 N $HClO_4$, and finally gold is eluted with 1 N $(NH_2)_2$ CS (thiourea) which forms a strong complex with gold. Most of the activities are radiochemically pure. The im-

purities found in a silica sample irradiated for 10 hours at a flux of 10^{14} neutrons/cm^2-sec vary from 4.1×10^{-8} wt.% for Au, 4.8×10^{-8} wt.% for W and 5.1×10^{-9} wt.% for Hg to 5.9×10^{-5} wt.% for Sn, 2.8×10^{-5} wt.% for Sb, and 1.9×10^{-6} wt.% for Mo. The time required for a complete analysis is about 4 hours. (TTT)

6378 RADIOCHEMICAL ANALYSIS BY THERMAL NEUTRON ACTIVATION: DETERMINATION OF COBALT BY MEASUREMENT OF THE ACTIVITY OF COBALT-60m (HALF LIFE OF 10.5 MINUTES). D. Monnier, W. Haerdi, and J. Vogel (Université, Geneva). Helv. Chim. Acta, 44: 1565-73(1961). (In French)

A method is described for the radiochemical assay of cobalt based on the formation of cobalt-60m after activation with thermal neutrons; the conditions of irradiation, the method for determination of loss during separation, and the influence of manganese-56 and of iron on this evaluation are given in detail. Following the procedure indicated it is possible to determine as little as 0.07 μg of cobalt with an accuracy of ±7%. For a single analysis the time required is 46.5 min, for ten analyses approximately 2 h. (auth)

6379 PAPER CHROMATOGRAPHY OF INORGANIC IONS. XIX. THE CHROMATOGRAPHY OF POLONIUM AND OTHER IONS ON ACETYLATED FILTER PAPER. Bente Klinken (Institut du Radium, Paris) and Michael Lederer. J. Chromatog., 6: 524-9(Dec. 1961). (In English)

The chromatographic behavior of metal ions on acetylated paper with butanol–HCl was investigated. The lower valencies of polonium were differentiated in this system. On acetylated cellulose, three differently moving species were observed in between Po(IV) and the lower valencies of Po: rather strongly adsorbed Po(IV), practically unadsorbed Po(II) which exists only in an atmosphere of SO_2, and a species obtained by the addition of reducing agents to Po(IV) and chromatography in air or CO_2, which has R_F values intermediate between Po(IV) and Po(II). (P.C.H.)

6380 GAMMA COUNTING MEASURES URANIUM IN FUEL ELEMENTS. Neil MacKinnon, Louis Sarkes, and Frederick May (Metals and Controls Inc., Attleboro, Mass.). Nucleonics, 20: No. 1, 72-3(Jan. 1962).

A method for counting gamma emissions from uranium-235 in each of 10000 uranium-aluminum alloy fuel elements is described. The method is used to ensure that uranium-235 is within 2½% of 1.82 g. The method shows 1% absolute accuracy and is much faster as a method for production inspection than weighing methods. The method is insensitive to surface irregularities. (N.W.R.)

6381 METHODS FOR Sr^{90} DETERMINATION AND POSSIBILITIES FOR IMPROVEMENT. Bernard Marchand (Universität, Freiburg i. B.). Strahlentherapie, 116: 615-19(Dec. 1961). (In German)

A simple procedure for the chemical analysis of Sr^{90} in materials rich in calcium and phosphate is reported. The usefulness of the present Sr^{90}-determination methods for the purposes of health control is discussed. (auth)

6382 A COMPARATIVE STUDY OF SOME LANTHANON CHELATES OF ALIZARIN COMPLEXAN AS REAGENTS FOR FLUORIDE. R. Belcher and T. S. West (Univ. of Birmingham, Eng.). Talanta, 8: 863-70(Dec. 1961). (In English)

A study was made of the comparative suitability of the cerium^{3+}, lanthanum, and praseodymium chelates of alizarin complexan as reagents for the spectrophotometric determination of microgram amounts of fluoride. The cerium^{3+} reagent is most sensitive at pH < 4.5 and the lanthanum reagent at pH ≥ 5.0. An enhancement of sensitivity may be obtained for both reagents at pH 4.3 by addition of acetone to 25% v/v, but the most sensitive means of determination is to use the lanthanum reagent in aqueous solution at pH 5.2 with measurement at 281 mμ. This procedure is 200% more sensitive than the standard method at 620 mμ. (auth)

6383 PHOTOMETRIC TITRATIONS. V. A SELECTIVE, CHELOMETRIC DETERMINATION OF COBALT. H. Flaschka and J. Ganchoff (Georgia Inst. of Tech., Atlanta). Talanta, 8: 885-91(Dec. 1961). (In English)

Cobalt can be titrated with good selectivity by converting it with hydrogen peroxide in alkaline medium to the cobalt(III) EDTA complex and back-titrating photometrically in acid medium the excess EDTA with bismuth solution, using pyrocatechol violet as indicator. No interference is observed with alkalies, alkaline earths, Ni, Cu, Cd, Zn, Pb, Al, U, and W. Bi, Zr, In, Ga, and other ions forming very stable EDTA complexes are co-titrated. Mo, Fe, Ag, and Hg interfere and should be separated. The interference of Mn can be excluded by addition of ascorbic acid. Th can be masked with sulfate. Cr(III) is co-titrated, but by applying a different method operating with two aliquots, both Cr and Co can be determined. Complexing anions interfere, as does chloride, which causes a turbidity with bismuth. (auth)

General Inorganic and Physical Chemistry

6384 (NAA-SR-6518) HEAT CONTENTS, $H_T - H_{298.1°K}$, FOR SOME HALIDES OF MERCURY, CADMIUM, AND BISMUTH AT THEIR MELTING POINTS. L. E. Topol and L. D. Ransom (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 30, 1961. Contract AT(11-1)-GEN-8. 4p.

The heat contents relative to 298.15°K and heat capacity data are given for $HgCl_2$, $BiCl_3$, $BiBr_3$, $CdCl_2$, $CdBr_2$, and CdI_2. No change was found in the heat capacity with temperature for any of the solid salts except $CdCl_2$ and $CdBr_2$. The heat content increments, except for the bismuth halides, was found to be in excellent agreement with literature estimates. (P.C.H.)

6385 (TID-14438) CHELATION AND OLATION REACTIONS OF AQUEOUS METAL IONS. Annual Progress Report [for] Work Completed through December 15, 1961. Arthur E. Martell (Illinois Inst. of Tech., Chicago). Dec. 1961. Contract AT(11-1)-1020. 71p.

Further developments and extensions in the ultracentrifugation technique for determining the molecular weights of metal chelate compounds are described. Additional experimenal work on uranyl complexes in solution was completed. A number of complexes were studied at different temperatures and the heats and entropies of complex formation were calculated. The equilibrium studies of other uranyl complexes were extended to a wider concentration range, and their tendencies to polymerize were determined. Incomplete studies of the thermodynamics of formation of incompletely-coordinated lanthanide complexes are described in outline form. (M.C.G.)

6386 (TID-14464) TECHNICAL PROGRESS REPORT [ON CHEMISTRY], DECEMBER 24, 1960 TO DECEMBER 1, 1961. Lynne L. Merritt, Jr. (Indiana Univ. Foundation Research Div., Bloomington, Ind.). Contract AT(11-1)-120. 35p.

The crystal structure of 1,2,5-thiadiazole-3,4-carboxamide was studied. Data are presented in graph and tabular form. The positional parameters of crystalline

dimethylglyoxime were refined by a three-dimensional (Fo– Fc) synthesis. The structure and space group of Cu_2O were studied. Work was begun to utilize electronic circuitry to construct a semi-micro analytical balance with completely automatic readout. (M.C.G.)

6387 (UCRL-9059) CHLORIDE COMPLEXES OF RUTHENIUM(III) (thesis). Dwight Albert Fine (California. Univ., Berkeley. Lawrence Radiation Lab.). Feb. 2, 1960. Contract W-7405-Eng-48. 81p.

Some chloride complexes of ruthenium(III) in aqueous solution were separated and identified. Two cationic complexes were identified as isomers of $RuCl_2^+$ by methods which utilize properties of ion exchange resins. Two neutral complexes were identified as isomers of $RuCl_3$ by freezing-point experiments and analyses. Two anionic complexes were identified as isomers of $RuCl_4^-$ by studies of equilibria involving the species. The complex $RuCl_5^{2-}$ was characterized by spectrophotometric study. A species presumed to be $RuCl_6^{3-}$ was found to exist at high chloride concentrations. Relationships between the complexes were investigated by spectrophotometry and ion exchange. Evidence regarding the configurations of the various pairs of isomers was obtained. The compositions of solutions of monomeric ruthenium(III) chloride complexes at equilibrium were determined; the dependence of the equilibrium composition on chloride concentration was measured. (auth)

6388 (AEC-tr-4449) JOURNAL OF INORGANIC CHEMISTRY. Translation of Zhurnal Neorganicheskoi Khimii, 3: No. 1, 3-239(1958). 282p. (PST-Cat.-371)

6389 (CEA-tr-R-1290) LA THERMOCHIMIE DES ISOTOPES. II. ETUDE DES CHALEURS DE FORMATION DU SELENIURE D'HYDROGENE ET DU SELENIURE DE DEUTERIUM. (The Thermochemistry of Isotopes. II. Study of the Heats of Formation of Hydrogen Selenides and of Deuterium Selenides). A. F. Kapustinskii (Kapustinsky) and R. T. Kankovskii (Kankovsky). Translated into French from Zhur. Fiz. Khim., 33: 722-6(1959). 17p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract no. 11660.

6390 (CEA-tr-R-1429) EQUATION D'ETAT POUR LE DEUTERIUM. (Equation of State for Deuterium). V. A. Rabinovich (Rabinovitsh). Translated into French from Inzhener.-Fiz. Zhur., Akad. Nauk Belorus. S.S.R., 3: No. 6, 107-11(June 1960). 11p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 20182.

6391 (CEA-tr-R-1431) ETAT DES MICROQUANTITES DE RADIOELEMENTS EN SOLUTION. IX. DE L'ETAT DES MICROQUANTITES DE ZIRCONIUM DANS LE DOMAINE DE L'HYDROLYSE. (Microquantities of Radioelements in Solutions. IX. On the State of Microquantities of Zirconium in Hydrolysis). I. E. Starik and I. A. Skul'skii (Skulski). Translated into French from Radiokhimiya, 1: 379-83(1959). 13p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 5244.

6392 (CEA-tr-X-405) CONTROLE DE LA PURETE DE L'EAU LOURDE PAR DES MESURES DE CONDUCTIBILITE ELECTRIQUE. (Control of the Purity of Heavy Water by Electric Conductivity Measurements). L. Selmi (Centro Informazioni Studi Esperienze, Milan). Translated into French from report CISE-28. [nd.]. 71p.

A conductimetric method for controlling the purity of heavy water is described. The concentrations at which certain elements cause capture reactions in a reactor are first calculated. Salt solutions containing the elements considered were prepared at the calculated concentrations. The presence of these elements was then detected by conductometry. The measurement apparatus consisted of a "General Radio" bridge, a detector, and an "Jena 16 III" glass cell with platinized electrodes. The cell constants were measured, and then the test solutions were measured. The results showed that all the elements considered except boron could be detected at concentrations which are nuclearly harmful. The behavior of boric acid was made the object of a special study, and it was decided that boric acid could be detected if it was transformed first into mannitoboric acid. (J.S.R.)

6393 COMPOSITION OF ALUMINUM NITRATE–NITRIC ACID MIXTURES BY SPECTROPHOTOMETRIC MEASUREMENTS. Robert W. Henry and Glenn L. Booman (Phillips Petroleum Co., Idaho Falls, Idaho). Anal. Chem., 32: 832-4(June 1960).

The ternary system aluminum nitrate–nitric acid–water was studied spectrophotometrically. Acid and aluminum concentrations are determinable by correlation of measured absorbances at 295 mμ and 2.667 microns. Use of these measurements enabled the prediction of free acid and aluminum concentrations to 0.03 and 0.02M (95% confidence limits) respectively, at the 1M range. Consideration of the limiting factors on the measurements indicates the feasibility of increasing the precision by a factor of seven, using a special-purpose instrument. (auth)

6394 THE EFFECT OF THE NATURE OF THE OXIDIZING AGENT ON THE DISSOLUTION OF URANIUM. G. M. Nesmeyanova. Atomnaya Energ., 11: 456-8(Nov. 1961). (In Russian)

A sample of pitchblende containing 67% uranium in which 22% was in the quadrivalent state as U(IV) was used to test the relative effectiveness of various oxidizing agents in acid solution in dissolving uranium. At a H_2SO_4 concentration of 10 to 25 g/l, HNO_3 and $KClO_3$ were more effective oxidizing agents than MnO_2, $Fe_2(SO_4)_3$ or $KMnO_4$. Increasing the temperature from 20 to 60°C led to a 75 to 80% increase in uranium extraction with the use of HNO_3 and $KClO_4$ as oxidizing agent, and to only a 15 to 20% increase in uranium extraction with the use of $KMnO_4$, MnO_2, or $Fe_2(SO_4)_3$. Nitric acid by itself was by far the most effective oxidant and extractive reagent. The relative data for the amount of uranium extracted in 30 minutes were 44% at 20°C and 98% at 90°C for the HNO_3 alone, 19% at 20°C and 96% at 90°C for the mixture of HNO_3 and H_2SO_4, 32% at 20°C and 95% at 90°C for the $KClO_3$ solution, 58% at 20°C and 78% at 90°C for the $KMnO_4$ solution, 52% at 20°C and 76% at 90°C for the $Fe_2(SO_4)_3$ solution, and 38% at 20°C and 68% at 90°C for the solution containing MnO_2. (TTT)

6395 EVIDENCE OF THE NATURE OF THE BONDS IN THE URANIUM SELENIDES U_2Se_3, U_3Se_4, AND USe. Parviz Khodadad (Faculté de Pharmacie, Paris). Compt. rend., 253: 1575-7(Oct. 9, 1961). (In French)

The nature of the bonding in U_2Se_3, U_3Se_4, and USe was investigated in the presence and absence of air using mercury bichloride as the reagent. In the absence of air the gain in degree of oxidation for the uranium was about 3.3 for all three compounds. In the presence of air the oxidation degree is equal to 6. The equations for the complete reactions both in the presence and absence of air are given. Because of the number of electrons set in action per atom of uranium in each group of reactions and because of the final oxidation degree of the metal, a zero oxidation degree is assigned to the moment of reaction with the Hg^{2+}

ions. The results lead to the conclusion that the U–Se bonds are covalent. (J.S.R.)

6396 ELEMENTARY MECHANISM IN THE GRAPHITIZATION PROCESS IN CARBON. Michel Oberlin and Jacques Mering (Institut National de Recherche Chimique Appliquée, Paris). Compt. rend., 253: 2720-2(Dec. 4, 1961). (In French)

The kinetics of wet-method oxidation of partially graphitized C show the existence of 3 different structural constituents. The respective proportions of these constituents are in agreement with the magnetic properties of C, and also with the results of crystallographic analysis. (tr-auth)

6397 THE DENSITIES OF SATURATED LIQUID HYDROGEN. R. D. Goodwin, D. E. Diller, H. M. Roder, and L. A. Weber (National Bureau of Standards, Boulder, Colo.). Cryogenics, 2: 81-3(Dec. 1961).

Densities of para-hydrogen from 17 to 32°K are obtained by extrapolating newly determined compressed liquid isotherms to corresponding vapor pressures. Results are combined with earlier data for the range 14 to 20°K and compared with normal hydrogen by means of density–temperature relationships. (auth)

6398 A STUDY OF THE INTERACTION OF AN AQUEOUS SOLUTION OF POTASSIUM METANIOBATE WITH OXALIC ACID. A. V. Lapitskii, L. G. Vlasov, E. P. Artamonova, and Yu. Zyulkovskii (Moscow State Univ.). Doklady Akad. Nauk S.S.S.R., 141: 101-3(Nov. 1, 1961). (In Russian)

The electrical conductivity, the optical density, turbidity, the decrease in freezing point, the viscosity, pH, and diffusion coefficients were measured in the $KNbO_3$–$H_2C_2O_4$–H_2O system at constant salt strength and at constant concentration of potassium niobate. A definite change in properties can be observed at a $KNbO_3 : H_2C_2O_4$ mol ratio of 1 to 0.5, and a second change is observed at a 1:1 mol ratio. The first stage of the reaction can be expressed as follows: $2KNbO_3 + H_2C_2O_4 = K_2C_2O_4 + 2HNbO_3$. Electromigration experiments showed that the niobium was present as a negative anion. From the self-diffusion experiments the composition of the oxalate complex was found to be $[NbO_2C_2O_4]^-$. The composition of the complex does not change on varying the ratio of $KNbO_3 : H_2C_2O_4$ from 1:1 to 1:10. The instability constant of the oxalate complex is estimated to be 8×10^{-4} on the basis of the optical density data. (TTT)

6399 THE HYDRIDING OF CERIUM–MAGNESIUM ALLOYS. V. I. Mikheeva and Z. K. Sterlyadkina (Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 141: 104-6(Nov. 1, 1961). (In Russian)

Cerium-magnesium alloys containing from 0 to 75 at.% Mg were subjected to hydriding at room temperature at a H_2 pressure of 0.5 to 1.0 atm. The hydrogen content of the hydrogenated alloy was determined by measuring the evolved H_2 on adding HCl to the sample. In alloys containing up to 5 at.% Mg a small constant amount of H_2 is absorbed. Starting with the alloy containing 30 at.% Mg the formula of the hydrided alloy is $Mg_mH_{2m}Ce_nH_{3n}$. At 50 at.% Mg the compound Mg_3Ce is formed, and H_2 is not absorbed. The hydriding of alloys enriched in Mg requires a considerate induction period of six hours to a number of days. The intermediate hydride $MgCeH_5$ is more stable than CeH_3. (TTT)

6400 DOUBLE OXIDES IN THE URANIUM–TUNGSTEN–OXYGEN SYSTEM. V. K. Trunov, L. M. Kovba, and V. I. Spitsyn (Moscow State Univ.). Doklady Akad. Nauk S.S.S.R., 141: 114-16(Nov. 1, 1961). (In Russian)

X-ray analysis showed that UO_2WO_4 is the only reaction product obtained on sintering a mixture of H_2WO_4 and $UO_2(OH)_2$ at 900°C for a period of 45 hours. The roentgenogram of UO_2WO_4 is similar to that of UO_2CrO_4 and UO_2MoO_4. A mixed oxide UWO_{3+x} was obtained by the thermal decomposition of UO_2WO_4 in vacuum at 600 to 900°C, by the reduction of uranyl tungstate with hydrogen at 300 to 800°C, and by sintering various uranium and tungsten oxide mixtures at 900 and 1250°C in evacuated ampules. No reaction between UO_2 and WO_2 could be observed up to 1250°C. (TTT)

6401 THE EMISSION OF POSITIVE MOLECULAR IONS FROM A HEATED SURFACE IN VACUUM. E. Ya. Zandberg and N. I. Ionov (Ioffe Inst. of Physics and Tech., Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 141: 139-42(Nov. 1, 1961). (In Russian)

The emission from a heated tungsten wire 18 to 50 μ in diameter in the ion source of a mass-spectrometer was followed as a function of temperature. All measurements were carried out at a residual pressure of 1 to 2×10^{-7} torrs obtained by a TsVL-100 oil pump operating via a liquid nitrogen trap. The wire was at a potential of 1300 volts, and the temperature of the wire was determined pyrometrically. At about $T \cong 400$°K, positive ion emission was observed at mass numbers of 59, 85, 96, 101, 102, and 202 with the 101 line being the most intense. On increasing the temperature to 1100°K, the current density of the 101 line was found to be 10^{-7} to 10^{-8} amps/cm^2. The emission makes its appearance at a temperature of 400 to 600°K. It is assumed that the cause of the emission is due to the catalytic decomposition of organic compounds on the heated wire, and that the oil pump is the source of the organic molecules. On increasing the electric field tension from $E_1 = 2.3 \times 10^3$ volts/cm to $E_2 = 2.3 \times 10^4$ volts/cm, the temperature threshold of the ionization is shifted about 100 degrees towards the side of lower temperatures. The magnitude of the emission current does not change. An emission of ions having a mass of 101 was also observed from nickel and iron wires, but this type of emission was not observed from platinum or gold-plated wires. (TTT)

6402 AN ISOTOPIC EFFECT IN THE RADIOLYTIC FORMATION OF HYDROGEN FROM POLYETHYLENE. V. E. Skurat (Inst. of Chemical Physics, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 141: 161-4 (Nov. 1, 1961). (In Russian)

High-pressure polyethylene samples and deuteropolyethylene (98 at.% D) samples (0.05 to 0.1g) were irradiated with 1.63-Mev electrons. Samples with known amounts of $(C_2H_4)_n$ and $(C_2D_4)_n$ were also prepared by dissolving the polymers in hot toluene and precipitating by addition of methyl alcohol. The amount of gas evolved was measured by means of a manometer, and the content of H and D was determined on a mass-spectrometer. The molecular yields of H_2 and D_2[$G_1(H)$ and $G_1(D)$ respectively] were determined. The molecular yield of deuterium $G_1(D)$ was found to be 0.37 ± 0.05 and did not depend on the dose within the interval of 10 to 60 megarads. The molecular yield of hydrogen $G_1(H)$ was 2.6 at 10 megarads, 2.3 at 20 megarads, and 2.1 at 50 megarads. The total radiation yields of H_2 and D_2 for the radiolysis of pure $(C_2H_4)_n$ and of pure $(C_2D_4)_n$ are 6.0 and 3.8 respectively. The molecular yield as a fraction of the total yield is $10 \pm 1.5\%$ for D_2 and $38 \pm 10\%$ for H_2. The radiation yield of hydrogen during the radiolysis of polyethylene and deuteropolyethylene decreases with in-

creasing dose because of the interaction of H and D with other free radicals and double-bond compounds. The radical yields were found to be $G_2(H) = 3.4$ and $G_2(D) = 3.43$. Since the radical yields are the same, the isotopic effect must be due to the reactions involving the evolution of molecular hydrogen. (TTT)

6403 ACCURATE DETERMINATION OF VAPOR PRESSURE DIFFERENCES OF ISOTOPIC COMPOUNDS. II. THE C^{13}/C^{12} ISOTOPE EFFECT IN CARBON TETRACHLORIDE AND BENZENE. Alfred Narten and Werner Kuhn (Universität, Basel). Helv. Chim. Acta, 44: 1474-9 (1961). (In German)

A method for determining vapor pressure differences of isotopic compounds is described. The method permits the determination of very small separation parameters with great accuracy. The C^{13}/C^{12} isotope effect was measured at vapor-liquid equilibrium in CCl_4 and C_6H_6. The sign and temperature pattern of the separation parameter is discussed on the basis of the Kaertschi-Kuhn theory (IR fraction of the dispersion interaction as origin for high volatility of heavy molecular species). (tr-auth)

6404 PLUTONIUM HEXAFLUORIDE THERMAL DECOMPOSITION RATES. Jack Fischer, L. E. Trevorrow, G. J. Vogel, and W. A. Shinn (Argonne National Lab., Ill.). Ind. Eng. Chem., Process Design Develop., 1: No. 1, 47-51 (Jan. 1962).

Uranium and plutonium may be recovered from nuclear reactor irradiated oxide fuel elements by fluoride volatility processing. Important to the process is the minimizing of loss when plutonium hexafluoride is transported through heated zones where thermal decomposition may take place. Thermal decomposition studies, both static and flow, have shown that the rate is dependent on the surface area of the plutonium tetrafluoride produced in the decomposition and the pressure of the hexafluoride. The hexafluoride can be efficiently recovered from the 500°C zone of the fluorination reactor by rapid quenching of the effluent gas and can be transferred without difficulty by distillation or by transpiration in a fluorine or helium stream. (auth)

6405 THE REACTIONS BETWEEN SILICA AND RARE EARTH OXIDES (La_2O_3, Nd_2O_3, Gd_2O_3) IN SOLID PHASE. E. K. Keler, N. A. Godina, and E. P. Savchenko (Inst. of Chemistry of Silicates, Academy of Sciences, USSR). Izvest. Akad. Nauk S.S.S.R., Otdel. Khim. Nauk, No. 10, 1728-35(Oct. 1961). (In Russian)

In reactions of La, Nd, and Gd oxides with silica at 1200 to 1400°, regardless of the initial mixture ratio, silicates with the following compositions are formed: $2La_2O_3 \cdot 3SiO_2$ and $La_2O_3 \cdot SiO_2$. Pyrosilicates $La_2O_3 \cdot 2SiO_2$ form at 1500 to 1650°. A small amount of pyrosilicates appear in $2La_2O_3 + 3SiO_2$ at 1500 to 1650° due to the decomposition of the orthosilicate. Pure lanthanum, neodymium, and gadolinium silicates were not observed in solid phase reactions. The compositions $La_2O_3 + SiO_2$ and $Nd_2O_3 + SiO_2$ annealed at 1500 to 1650° form $La_2O_3 \cdot SiO_2$ and $Nd_2O_3 \cdot SiO_2$. (R.V.J.)

6406 THE REACTIONS BETWEEN SILICA AND PRASEODYMIUM OXIDE IN SOLID PHASES. E. K. Keler, N. A. Godina, and E. P. Savchenko (Inst. of Chemistry of Silicates, Academy of Sciences, USSR). Izvest. Akad. Nauk S.S.S.R., Otdel. Khim. Nauk, No. 10, 1735-41(Oct. 1961). (In Russian)

Reactions of praseodymium oxide with silica form the following silicates: $Pr_2O_3 \cdot SiO_2$, $2Pr_2O_3 \cdot 3SiO_2$, and $Pr_2O_3 \cdot 2SiO_2$. Silicates are also formed in silica reactions with Pr_6O_{11} in hydrogen or air. Orthosilicate formation in hydrogen or air at 1200 to 1300° is independent of the ratio between praseodymium oxide and silica. At the temperatures exceeding 1400 to 1650° the orthosilicate is unstable and disintegrates into $Pr_2O_3 \cdot SiO_2$ and $Pr_2O_3 \cdot 2SiO_2$. The pyrosilicate, $Pr_2O_3 \cdot 2SiO_2$, forms at 1400 to 1650° as a second reaction stage. Oxiorthosilicate, $Pr_2O_3 \cdot SiO_2$, with a small amount of orthosilicate is produced at 1600 to 1650°. (R.V.J.)

6407 THE INFLUENCE OF THERMODYNAMIC ISOTOPE EFFECT ON THE DISTRIBUTION OF ISOTOPIC MOLECULES. G. A. Skorobogatov (Inst. of Chemistry of Silicates, Academy of Sciences, USSR). Izvest. Akad. Nauk S.S.S.R., Otdel. Khim. Nauk, No. 10, 1763-71(Oct. 1961). (In Russian)

The thermodynamic isotopic effect is capable of diverting molecular distribution from the statistical, especially with light elements. A method is suggested for developing algebraic equations for calculating the isotopic molecular content of any chemical compound consisting of an arbitrary number of various isotopes. The solutions are derived for several simple problems. (R.V.J.)

6408 REACTIONS OF Ce_2O_3 AND SiO AT ELEVATED TEMPERATURES. A. I. Leonov, V. S. Rudenko, and E. K. Keler (Inst. of Chemistry of Silicates, Academy of Sciences, USSR). Izvest. Akad. Nauk S.S.S.R., Otdel. Khim. Nauk, No. 11, 1925-33(Nov. 1961). (In Russian)

Three chemical compounds, $Ce_2O_3 \cdot SiO_2$, $2Ce_2O_3 \cdot 3SiO_2$, and $Ce_2O_3 \cdot 2SiO_2$, are formed in Ce_2O_3 reactions with SiO_2 in hydrogen atmosphere. Crystalline $Ce_2O_3 \cdot 2SiO_2$ was synthesized from a mixture of $Ce_2O_3 + 2SiO_2$. $Ce_2O_3 \cdot SiO_2$ and $2Ce_2O_3 \cdot 3SiO_2$ are unstable and disintegrate when heated in air. The stability pattern is as follows: $Ce_2O_3 \cdot SiO_2 < 2Ce_2O_3 \cdot 3SiO_2 < Ce_2O_3 \cdot 2SiO_2$ with disintegration temperatures of 300 to 500°, 600 to 700°, and 900°C, respectively. (R.V.J.)

6409 PHYSICO-CHEMICAL STUDIES OF LANTHANUM HYDROXIDE REACTIONS WITH HYDROGEN PEROXIDES. S. Z. Makarov, L. V. Ladeinova-Soboleva, and A. M. Chernyshova (Kurnakov Inst. of General and Inorganic Chemistry, USSR). Izvest. Akad. Nauk S.S.S.R., Otdel. Khim. Nauk, No. 11, 1933-40(Nov. 1961). (In Russian)

Reactions of $La(OH)_3$ with various concentrations H_2O_2 at 0 to 20°C formed two phases, $La_2O_4 \cdot 2H_2O$ and $LaO_4 \cdot H_2O$. Dehydration experiments failed to produce anhydrous lanthanum peroxide. (R.V.J.)

6410 PHYSICO-CHEMICAL STUDIES OF NEODYMIUM HYDROXIDE REACTION WITH HYDROGEN PEROXIDE. S. Z. Makarov and L. V. Ladeinova-Soboleva (Kurnakov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Izvest. Akad. Nauk S.S.S.R., Otdel. Khim. Nauk, No. 11, 1940-6(Nov. 1961). (In Russian)

Reactions of $Nd(OH)_3$ with H_2O_2 exhibited two solid peroxide phases, $Nd_2O_5 \cdot 2H_2O$ and $Nd_2O_4 \cdot 2H_2O$. (R.V.J.)

6411 MELTING POINTS OF INORGANIC FLUORIDES. Bernard Porter and E. A. Brown (Bureau of Mines, Reno, Nev.). J. Am. Ceram. Soc., 45: 49(Jan. 1962).

The melting points of BaF_2, CaF_2, CeF_3, GdF_3, KF, LaF_3, LiF, NaF, SrF_2, ThF_4, and YF_3 are given. The dried powder was loaded in an argon atmosphere into a graphite crucible. The individual fluorides were taken to 40 to 50°C above their melting points and stirred before beginning measurements. A series of heating and cooling runs was made, and the temperature-time curves were recorded on a potentiometer recorder. Literature values are also tabulated to show the wide range of melting points in current use. (P.C.H.)

6412 THE ISOTOPIC EXCHANGES EFFECTED, FROM A MIXTURE IN THE LIQUID OR VAPOR PHASE OF ALIPHATIC AMINES OR OF DIMETHYLHYDRAZINE WITH HEAVY WATER. Guy Pannetier, Henri Guenebaut, Louis Marsigny, and Pascal Deschamps. J. chim. phys., 58: 790-6(Sept. 1961). (In French)

The mixture in aqueous or vapor phase of aliphatic amines or of dimethylhydrazine with D_2O can give rise to isotopic exchanges. A spectroscopic study of the atomic flame reaction of these mixtures with oxygen or nitrogen, activated by high-voltage electric discharge, showed that the isotopic exchange is made exclusively with hydrogen atoms bound to a nitrogen atom, in agreement with the Brodsky theory. The work also showed that the reaction of aliphatic amines or of dimethylhydrazine with atomic oxygen or activated nitrogen occurs by very different processes with respect to the formation of the radicals NH or ND. (tr-auth)

6413 ION-EXCHANGE IN CONCENTRATED ELECTROLYTE SOLUTIONS. I. THE SYSTEM LITHIUM CHLORIDE–ALKALI CHLORIDE–DOWEX-50. Walter A. Platek and Jacob A. Marinsky (Univ. of Buffalo). J. Phys. Chem., 65: 2113-17(Dec. 1961).

The ion-exchange behavior of trace components was studied by measuring the variation of selectivity, K_{Li}^{M}, as a function of external LiCl molality using Dowex-50 in the Li form. A molality range of 0.1 to 13.5 was investigated with the trace component MCl, including NaCl, RbCl, CsCl, and HCl, respectively. The effect of temperature in the range of 25 to 170° also was studied to facilitate evaluation of thermodynamic exchange functions for these systems. The results are considered primarily on the basis of ionic hydration and binding. (auth)

6414 ION-EXCHANGE IN CONCENTRATED ELECTROLYTE SOLUTIONS. II. THE SYSTEM LITHIUM CHLORIDE–ALKALI CHLORIDE–ZEOLITE. Walter A. Platek and Jacob A. Marinsky (Univ. of Buffalo). J. Phys. Chem., 65: 2118-22(Dec. 1961).

The ion-exchange behavior of trace components was studied by measuring the variation of selectivity, L_{Li}^{M}, as a function of external LiCl molality using a Linde "Molecular Sieve" as the exchanger. A molality range of 0.1 to 13.5 was investigated with the trace component MCl including NaCl, RbCl, and CsCl. The exchange reactions also were studied as a function of temperature in the range 25 to 97.5° and in fused LiCl at 650°. The thermodynamic exchange functions were calculated, and the zeolite exchanger compared to a typical organic exchanger. (auth)

6415 THE EFFECT OF DISSOLVED ALKALI HALIDES ON THE RAMAN SPECTRUM OF WATER. J. W. Schultz and D. F. Hornig (Brown Univ., Providence and Princeton Univ., N. J.). J. Phys. Chem., 65: 2131-8(Dec. 1961).

The Raman spectra of aqueous solutions of LiCl, LiI, KF, KI, CsF, and CsI were studied at several concentrations. The striking conclusion is that the intensity of both the bending and stretching vibrations are strongly affected by the nature of the anion, decreasing slightly in the presence of F^-, increasing slightly with Cl^- and increasing up to eight times in the presence of I^-. Equally striking is the observation that there is no detectable effect of the cation, LiI and CsI yielded substantially identical spectra. There is no evidence for the presence of more than one kind of water molecule, either in pure water or in any of the solutions. (auth)

6416 FLUORINE BOMB CALORIMETRY. III. THE HEAT OF FORMATION OF BORON TRIFLUORIDE. Stephen S. Wise, John L. Margrave, Harold M. Feder, and Ward N. Hubbard (Argonne National Lab., Ill. and Univ. of Wisconsin, Madison). J. Phys. Chem., 65: 2157-9(Dec. 1961).

The heat of formation of boron trifluoride was measured by direct combination of the elements in a bomb calorimeter. ΔH_f° at 25° was found to be -270.10 ± 0.24 kcal. mole^{-1}. (auth)

6417 THE HEATS OF DECOMPOSITION OF SOME HIGHER BORON HYDRIDES. Stuart R. Gunn and LeRoy G. Green (Univ. of California, Livermore). J. Phys. Chem., 65: 2173-5(Dec. 1961). (UCRL-6458)

Heats of decomposition of B_4H_{10}, B_5H_9, B_5H_{11}, and B_6H_{10} were determined by explosion of mixtures with SbH_3. Bond energies of boron hydrides are derived and discussed. (auth)

6418 THE THALLOUS-THALLIC EXCHANGE AT VARIOUS ACIDITIES IN PERCHLORATE MEDIA. Edwin Roig and Richard W. Dodson (Puerto Rico Nuclear Center, Rio Pedras and Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem., 65: 2175-81(Dec. 1961). (BNL-5545)

The Tl(I)–Tl(III) electron exchange rate was measured at 25° in 3f $NaClO_4$–$HClO_4$ media at various acid concentrations down to 0.1f. Since the hydrolysis equilibria of Tl(III) were measured under the same conditions, the results permit a more accurate comparison of the reactivities of Tl^{3+} and $TlOH^{2+}$ than was possible previously. In contrast to results at higher ionic strengths, the rate is found to decrease as the acidity is decreased. The rate law can be written as $R = k_0(Tl^+)(Tl^{3+}) + k_1(Tl^+)(TlOH^{2+})$, with $k_0 = 0.253 \pm 0.005\ f^{-1}$ hr^{-1} and $k_1 = 0.089 \pm 0.012\ f^{-1}$ hr^{-1}. No evidence is found for an exchange of Tl^+ with $Tl(OH)_2^+$; an upper limit of $0.1\ f^{-1}$ hr^{-1} is assigned to the specific rate of this reaction path. Measurements also were made at 15 and 35°. The activation energy for k_0 is 17.4 kcal/mole. (auth)

6419 PHASE EQUILIBRIA IN FUSED SALT SYSTEMS: BINARY SYSTEMS OF PLUTONIUM(III) CHLORIDE WITH THE CHLORIDES OF MAGNESIUM, CALCIUM, STRONTIUM AND BARIUM. K. W. R. Johnson, Milton Kahn, and J. A. Leary (Univ. of New Mexico, Albuquerque and Los Alamos Scientific Lab., N. Mex.). J. Phys. Chem., 65: 2226-9 (Dec. 1961).

Thermal and differential thermal analysis techniques, supplemented by microscopic examination of cooled melts, were used to investigate phase equilibrium diagrams for the binary systems: $PuCl_3$–$MgCl_2$, $PuCl_3$–$CaCl_2$, $PuCl_3$–$SrCl_2$, $PuCl_3$–$BaCl_2$. The $PuCl_3$–$MgCl_2$ and $PuCl_3$–$CaCl_2$ systems are characterized by single eutectic points: the $PuCl_3$–$SrCl_2$ and $PuCl_3$–$BaCl_2$ systems are characterized by peritectic transformations and solid solutions. Compounds of the type M_3PuCl_9 (M = Sr or Ba) are associated with the peritectic transformation and solid solutions occur in compositions which are rich in $SrCl_2$ or $BaCl_2$. (auth)

6420 A STUDY OF THE RATE OF ISOTOPIC EXCHANGE FOR Zn^{65} IN MOLTEN ZINC-ZINC CHLORIDE SYSTEMS AT 433-681°. A. G. Buyers (Hughes Research Labs., Malibu, Calif.). J. Phys. Chem., 65: 2253-7(Dec. 1961).

The controlling rate and the mechanism for transfer of Zn^{65} from molten zinc to zinc chloride in stirred melts with constant interfacial area of contact are given. This was accomplished by measuring the temperature dependence for the rate of exchange of Zn^{65} between molten zinc and zinc chloride in isothermal contact in the temperature range 433 to 681°. Accordingly, studies were carried out which included: one series of exchange experiments

wherein both phases of this two phase melt were saturated with each other; and a second group of experiments using unsaturated phases. The temperature dependence for the exchange half-time expressed below applied, respectively, to these series log $t_{\frac{1}{2}} = -1.220 + 2120/T$ and log $t_{\frac{1}{2}} = -1.800 + 2092/T$. Interpretation of these results and examination of prior data disclosed that the rate-controlling step for the transfer of Zn^{65} from molten zinc to zinc chloride is an interfacial reaction which may involve the formation and dissociation of Zn_2^{2+}. An average activation energy for this transfer process was calculated to be 9.8 ± 1 kcal/mole. (auth)

6421 ION DEPOSITION ON VARIABLE CAPACITY CATION AND ANION ADSORBENTS. Elwira Herczyńska (Inst. of Nuclear Research, Polish Academy of Science, Warsaw). Nukleonika, 6: 735-48(1961). (In English)

The distribution coefficient expression in primary and secondary ion exchange is derived for variable capacity adsorbents. Theoretical formulas are compared with experimental results for Zn^{65} and P^{32}-phosphate sorption onto Cu, Sn, and glass surfaces. (auth)

6422 SOME PROPERTIES AND APPLICATIONS OF THE RARE-GAS CLATHRATE COMPOUNDS. J. E. Mock, E. A. Trabant, and J. E. Myers (Purdue Univ., Lafayette, Ind.). Purdue Univ., Eng. Bull., Research Ser., No. 145, 1-20(Sept. 1961).

Some possible applications of the rare-gas clathrate crystalline compounds are discussed; e.g., such materials could be used to advantage in the handling and permanent disposal of radioactive rare gases, in the preparation of standardized irradiation sources, as a convenient form for containing rare-gas radioisotopes to be used as radiographic and gaging sources of radiation, and in the measurement and study of the nuclear properties of the rare-gas isotopes. Several convenient methods for preparing these unique compounds are described along with certain of their physical properties. Data are presented which show that the clathrate compounds are stable to a gamma dose of 1.14×10^8 rads; and equations are given which describe the temperature distribution of radioactive slabs for various boundary conditions. A generalized plot is presented for alpha emitters, and an analysis based upon diffusion theory is accomplished for beta emitters. Computational results are given which define the size limitation imposed on clathrate materials to assure their thermal stability. (auth)

6423 VIBRATIONAL MEAN-SQUARE AMPLITUDE MATRICES. XII. GENERALIZED MEAN-SQUARE AMPLITUDES OF SOME MOLECULES. S. J. Cyvin (Univ. of Norway, Trondheim). Spectrochim. Acta, 17: 1219-29(Dec. 1961).

Expressions are given for the generalized mean-square amplitudes (mean-square parallel amplitudes, mean-square perpendicular amplitudes, and mean cross products) in terms of the Σ matrix elements for the following molecular models: linear YXZ, regular trigonal X_3, plane square X_4, tetrahedral X_4, linear symmetrical XY_2, bent symmetrical XY_2, planar symmetrical XY_3, and tetrahedral XY_4. Numerical values of the mentioned quantities are reported for $C^{12}O_2$, $C^{13}O_2$, $C^{14}O_2$, OCS, OCSe, CS_2, SCSe, CSe_2, SCTe, P_4, $N^{14}O_2$, $N^{15}O_2$, $B^{11}F_3$, $B^{11}Cl_3$, $B^{11}Br_3$, and $B^{11}I_3$. (auth)

6424 THE LIBRATIONAL SPECTRA OF WATER AND HEAVY WATER IN CRYSTALLINE SALT HYDRATES. Jan van der Elsken and W. Robinson (Johns Hopkins Univ., Baltimore). Spectrochim. Acta, 17: 1249-56(Dec. 1961).

Infrared spectra are reported of nine mono- and dihydrates of alkali halides and alkaline earth halides. These spectra in the 300–600 cm^{-1} region are interpreted as arising from the librational modes of the bound water molecules as shown unambiguously by the frequency changes on substitution of deuterium oxide. Potential constants for this motion are given. Samples were prepared by evaporation of salt films in situ and the method is seen to be of value for studying the limits of phase stability of unknown hydrates and related compounds. The number of bands observed in this region indicates for all cases studied the number of water molecules with different crystalline environments. (auth)

6425 CONTRIBUTION TO THE SYNTHESIS OF SOME METALCARBAMATE COMPLEXES. H. Malissa and H. Kolbe-Rohde (Technische Hochschule, Vienna and Max-Planck-Institut für Eisenforschung, Düsseldorf). Talanta, 8: 841-5(Dec. 1961). (In German)

The empirical formulas, crystal habits, and x-ray patterns are presented for Ag, Cu, Zn, Cr, Mn, Fe, U, Cd, Bi, Ni, Mo, and Nb carbamate complexes. (auth)

6426 STRUCTURE OF NIOBATES AND TANTALATES. A. V. Lapitskii, D. Nishanov, and V. A. Pchelkin (Moscow State Univ.). Vestnik Moskov. Univ., Ser. II, No. 6, 18-23(1960).

The possibility of setting up a general structural formula for polyaqua compounds of niobium and tantalum is discussed. The thermal dehydration of salts was studied, and it was found that a great part of the water, (approximately 75%) splits off at 80-120°C. The residual amounts can be removed only very slowly, and a complete dehydration can only be obtained at a sufficiently high temperature: 300-400°C for tantalates, 400-500°C for niobates. The thermograms of all salts show that thermal dehydration is accompanied by endothermic or exothermic effects. The Debye patterns of air-dried salts are characterized by lines of different intensity; those of partly dehydrated salts show a distinct diffusion picture, while completely dehydrated salts show the simple lines of meta salts. This indicates that in the course of dehydration, the crystal lattice of the initial salt is destroyed and a lattice of the dehydrated meta salt is formed. The data given on the dehydration of different niobates and tantalates show that by an increase of the number of central atoms (niobium and tantalum), the bonding strength of water in the anion is increased. The number of molecules remaining bound in the salt above 100°C is constant, and half a molecule of water goes to one atom of niobium (tantalum) in the anion. Bridges are formed between the O-atoms of the water and the O-atoms of the metal (molybdenum) by means of the H-bond. The water bound in the polyaqua compounds is bound not only to the cations but also to the anions. The water molecules surrounding the cations from polyhedra. The amount of water depends on the ionic radius and the polarizing effect of the cation. The water, which is split off most easily, belongs to the outer sphere of the salt. The firmly bound water is bound in the anions. The bond between the atoms of the metals results from H-bonding. The structure of the analyzed niobates or tantalates can be explained by the behavior of water in dehydration. The general formula reads: $Me_n[(H\theta_6O_{19})_2 \cdot nH_2O] \cdot mH_2O$, where θ = Nb, Ta; Me = Li, Na, K, etc; n = 1–5; x = 14, 16; mH_2O is the part of water which coordinates around the cations. (OTS)

6427 ON LITHIUM METAZIRCONATE AND METAHAFNATE. A. A. Grizik and V. E. Plyushchev. Zhur. Neorg. Khim., 6: 2249-53(Oct. 1961). (In Russian)

X-ray phase analyses were made of $Li_2Me(IV)O_3$ produced by reactions between Li_2CO_3 and $ZrO_2(HfO_2)$. The

density, melting point, and chemical characteristics of Li_2ZrO_3 and Li_2HfO_3 were determined. (R.V.J.)

6428 INFRARED ABSORPTION SPECTRA OF COMPLEX COMPOUNDS Ir(III) WITH INTERSTITIAL SULFITE GROUP. A. V. Babaeva, Yu. Ya. Kharitonov, and Z. M. Novozhenyuk (Kurnakov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Zhur. Neorg. Khim., 6: 2263-80(Oct. 1961). (In Russian)

Infrared absorption spectra (400 to 2000 cm^{-1}) of Ir(III) crystalline complex compounds containing sulfite groups in the interstitial region were studied in order to determine the sulfite group bond with the central atom. The spectral data for the monodentate sulfite group indicate a coordinate Ir—S bond, an S—O bond strengthening, and increased OSO angles. (R.V.J.)

6429 URANIUM(IV) OCTARHODANIDES. V. P. Markov and E. N. Traggeim (Kurnakov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Zhur. Neorg. Khim., 6: 2316-18(Oct. 1961). (In Russian)

Complex compounds of $[U(SCN)_8]^{4-}$ were prepared and the following derivatives were separated: $Rb_4[U(SCN)_8]$, $Cs_4[U(SCN)_8]H_2O$, $[C_{10}H_8N_2H]_4$, and $[U(SCN)_8]$. (R.V.J.)

6430 ANALYSIS OF THE PRECIPITATE FORMED BY REACTION OF AMMONIA WITH AQUEOUS SOLUTIONS OF URANYL NITRATE AND SULFATE. N. P. Galkin, A. A. Maiorov, V. A. Shubin, G. B. Poluektova, and A. S. Krylov. Zhur. Neorg. Khim., 6: 2319-24(Oct. 1961). (In Russian)

A complex ammonium uranyl sulfate salt, $(NH_4)_2(UO_2)_2SO_4(OH)_4 \cdot 3H_2O$, which slowly dissolves into uranyl hydroxide and ammonium sulfate, forms during ammonium precipitation of uranyl sulfate. Ammonium diuranate is precipitated by ammonium from dilute solutions of uranyl sulfate solutions (< 3% SO_4^{2-} in mother liquor) at pH 8. A complex salt, $(NH_4)_3(UO_2)_4NO_3(OH_{10} \cdot nH_2O$, which hydrolyses in water to ammonium hexauranate, separates from ammonium precipitated concentrated uranyl nitrate solutions (100 g/l), while ammonium tetrauranate with five water molecules is formed in 0.1 N uranyl nitrate precipitation by ammonium. (R.V.J.)

6431 SOLUTION OF Ti^{3+} ION IN AQUEOUS SOLUTIONS. I. I. Antipova-Karataeva, E. E. Vainshtein, and Yu. I. Kutsenko (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Zhur. Neorg. Khim., 6: 2329-33(Oct. 1961). (In Russian)

Absorption spectra of Ti^{3+} chloride are studied at concentrations from 0.01 to 1.0 N in aqueous solutions containing additional chloride ions. At mean and low Ti^{3+} concentrations, the hydrates have tetragonal bipyramid symmetry; in aqueous solutions with increased chloride ion content $TiCl_3$ solvants containing Cl^- ions are formed that have a rhombic shape and low symmetry. (R.V.J.)

6432 POLARISCOPIC INVESTIGATION OF FUSED POTASSIUM FLUOZIRCONATE. I. N. Sheiko, A. V. Gorodyskii, and M. I. Bykova. Zhur. Neorg. Khim., 6: 2341-3 (Oct. 1961). (In Russian)

Investigations were made of the electrode polarization of potassium fluozirconate in a molten, equimolar mixture of potassium and sodium chlorides. Two forms of fluozirconates were observed in the melt; both are reduced in stages. (R.V.J.)

6433 BINARY SYSTEM OF $Nd_2O_3—Al_2O_3$ AND $Nd_2O_3—Al_2O_3—SiO_2$. N. A. Toropov and T. P. Kiseleva. Zhur. Noerg. Khim. 6: 2353-8(Oct. 1961). (In Russian)

A constitution diagram of neodynium—aluminum oxide was prepared. It is shown that neodymium monoaluminate melts congruently at 2070°C. The crystals of the compound have two diffraction indicies, $N_g = 2.025$ and $N_p = 2.013$. Picnometric density is 7.031 g/cm^3. The absorption bands of $Nd_2O_3 \cdot Al_2O_3$ in the infrared region are within 800 to 850 and 1000 to 1100 cm^{-1}. The phase diagram exhibits two eutectics at 1800°C, with 75 mole % Nd_2O_3, and at 1750°C, with 20 mole % Nd_2O_3. Studies were also made of $Nd_2O_3—Al_2O_3—SiO_2$. It was found that aluminum oxide in this system cannot act as a homogenizer. (R.V.J.)

6434 INVESTIGATION OF COMPLEX FORMATION OF URANYL WITH TRIOXYGLUTARIC ACID. P. N. Palei and Li-yüan Hsü (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Zhur. Neorg. Khim., 6: 2406-13(Oct. 1961). (In Russian)

Uranyl ions with trioxyglutaric acid at pH3 form a neutral complex compound that is stable in the presence of saturated trioxyglutaric acid. At pH6 the anion complex is more stable. The following compounds were separated by precipitation with methyl alcohol: at pH3, $(UO_2)_2 \cdot C_5H_4O_7 \cdot 3H_2O$, at pH6, $NaUO_2C_5H_5O_7 \cdot 2H_2O$, and at pH10, $Na_2UO_2C_5H_4O_7 \cdot 4H_2O$. (R.V.J.)

6435 THE FLUORIDES OF THE ACTINIDE ELEMENTS. N. Hodge (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.138-82 of "Advances in Fluorine Chemistry. Volume 2." M. Stacey, J. C. Tatlow, and A. G. Sharpe, eds. London, Butterworths, 1961.

Both horizontal and vertical relationships between the actinide fluorides are described. The horizontal relationship is expressed in the classification of the elements (actinium, americium, curium, plutonium, protactinium, neptunium, thorium, and uranium) in terms of valency and in the ability of a small anion to polarize to bring out the highest oxidation state of a particular element. The vertical treatment of each actinide fluoride is discussed separately as far as possible under the loose headings of preparative procedures, physical properties, chemical properties, and systems and complex compounds. (N.W.R.)

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Refer also to abstract 6820

6436 (NP-11231) ERGEBNISSE CHEMISCHER UNTERSUCHUNGEN ÜBER DIE KERNSPALTUNG. HABILITATIONSSCHRIFT. (Results of Chemical Investigations on Nuclear Fission (thesis)). Guenter Herrmann (Johannes-Gutenberg-Universitat, Mainz). 1961. 294p.

The fission chains are discussed. The methods for the determination of independent and cumulative fission yields are described. Cumulative yields in low-energy fission were compiled and the resulting mass-yield curves are given. Mass distributions from fission are discussed and experimental data summarized. Yields which were used in a study of nuclear charge distribution are presented in tabular form. A general discussion of the charge distribution and the postulates made for their explanation are given. The dumbbell-shaped model of the fissioning nucleus is discussed. (M.C.G.)

6437 (NYO-2530) THE ACCELERATING EFFECT OF ADDITIVES ON RADIATION-INDUCED GRAFT POLYMERIZATION. Annual Report. George Odian, Marjorie Sobel, Robert Klein, and Terese Acker (Radiation Applications Inc., Long Island City, N. Y.). Feb. 1, 1961. Contract AT(30-1)-2318. 79p.

Two broad areas of radiation-induced graft polymerization were investigated during the past year. A study was made of the effects of various solvents on the process of radiation-induced graft polymerization. It was found that the use of the proper solvent has a pronounced accelerative effect on the grafting rate. Methanol accelerates the radiation-induced grafting of styrene to low density polyethylene, high density polyethylene, polypropylene, polyvinyl chloride and nylon. Methanol also accelerates the radiation-induced grafting of methyl acrylate to nylon, polypropylene, and high density polyethylene. Hexane accelerates the radiation-induced grafting of t-butylaminoethyl methacrylate to low density polyethylene. Mechanisms which appear to be responsible for accelerative effects include the Trommsdorff effect of the solvents, and the swelling effect of certain solvents on various polymers. The former mechanism is responsible for the effects observed in the cases of polyethylene, polypropylene, polyvinyl chloride and Teflon in the graft polymerization of styrene, methyl acrylate, and t-butylaminoethyl methacrylate. The latter mechanism is responsible for the effects observed in the grafting of styrene and methyl acrylate to nylon. Radiation-induced grafting via the technique of irradiation of resin-monomer mixtures was also investigated. Monomer and polymer were mixed above the melt point of the latter and some of the properties of the irradiated blends examined. It was found that irradiated polyethylene-vinyl stearate mixtures showed increased plasticization, and irradiated blends of polyethylene with diallyl phosphite and triallyl phosphate show improved temperature stability. (auth)

6438 (TID-14466) RADIOCHEMICAL STUDIES OF FISSION PROCESSES. Progress Report for period April 1, 1961 to April 1, 1962. A. C. Wahl (Washington Univ., St. Louis). Dec. 11, 1961. Contract AT(11-1)-85. 6p.

The yields of yttrium isotopes from thermal neutron fission of U^{235} were measured. Fission-product precursors were investigated and the yield of 27-hr Sn^{121} from fission of U^{231} was determined. A device was developed for automatic rapid removal of irradiated solutions from pneumatic rabbits. Strontium from thermal neutron fission of U^{235} was purified and gamma and beta spectra taken as a function of time. The decay scheme of Sr^{93} was determined. (M.C.G.)

6439 (CEA-tr-R-1388) INTERACTION DU SOUFRE ET DU CAOUTCHOUC NATUREL SOUS L'ACTION DE RAYONNEMENTS IONISANTS. (Interaction of Sulfur and Natural Rubber Under the Action of Ionizing Radiations). Z. N. Tarasova, M. Ya. (Ia.) Kaplunov, V. T. Kozlov, N. A. Klauzen, and B. A. Dogadkin. Translated into French from Vysokomolekulyarnye Soedineniya, 2: 1201-6(1960). 18p.

The effect of sulfur on the kinetics of the radioinduced structuration of natural rubber and the properties of products vulcanized by irradiation were studied. Under the effect of ionizing radiation at 25°C, the addition of a considerable quantity of sulfur is observed; the quantity increases with the dose increase. The elevation of the irradiation temperature increases the velocity of the sulfur addition. The presence of sulfur decreases the structuration. Increase of the temperature from −80 to 100°C during the irradiation causes an intensification of the structuration. With pure rubber, at a temperature higher than 50°C, a reversion of the structuration process is observed, although in the presence of sulfur up to 100°C, this phenomenon is not observed. During irradiation in argon of natural rubber and its mixtures with sulfur, a considerable decrease of the nonsaturation is noticed. For mixtures with sulfur, this decrease is less marked. Vulcanates containing sulfur, independently of the irradiation dose up to 100 Mr, have 40% of the sulfur free for exchange. Vulcanates containing sulfur, under irradiation, have a rupture resistance and a relatively greater elongation, especially at high temperatures. The thermomechanical resistance of such vulcanates is lower than that of products vulcanized under irradiation from pure rubber. (tr-auth)

6440 (CEA-tr-R-1434) PREPARATION DE CONCENTRATS DE CESIUM RADIOACTIF AVEC EMPLOI DE COLONNES DE GLAUCONITE ECHANGEUSES D'IONS. (Preparation of Concentrated Radioactive Cesium by Means of Glauconite Ion Exchange Columns). S. Z. Roginskii, O. V. Altschuler, M. I. Yanovskii (Janovskii), E. I. Malinina, and A. E. Morokhovets. Translated into French from Radiokhimiya, 2: 431-7(1960). 23p. (Includes original, 7p.).

This paper was previously abstracted from the original language and appears in NSA, Vol. 15, abstract no. 2670.

6441 (CEA-tr-R-1442) PREPARATION D'EMETTEURS ALPHA PLANS EN POLONIUM DE GRANDE ACTIVITE. (Preparation of Flat Polonium Alpha Emitters of High Activity). I. N. Plaksin (Plaksine), V. N. Smirnov (Smirnoff), and L. P. Starchik. Translated into French from Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk, Met. i Toplivo, No. 5, 122-3(Sept.-Oct. 1959). 7p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 17871.

6442 (CEA-tr-R-1448) MECANISME DE LA RADIOLYSE DE L'EAU. (Mechanism of the Radiolysis of Water). V. V. Voevodskii (Voevodski). Translated into French from Kinetika i Kataliz, 2: 14-20(Jan.-Feb. 1961). 16p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 15, abstract no. 26096.

6443 A UNIVERSAL METHOD FOR CHEMICAL ANALYSIS AND RADIOACTIVITY MEASUREMENT OF SUBSTANCES CONTAINING ^{14}C. K. H. Schweer and E. Uhlmann (Kernforschungszentrums, Karlsruhe, Ger.). Atompraxis, 7: 453-9(Dec. 1961). (In German)

The method described can be used to analyze all organic and inorganic substances containing C^{14}: in each case the carbon is converted to CO_2. The error of C-analysis on micro-scale is 0.5%, on semimicro-scale ±0.3% and on macroscale ±0.1%. The limit of detection is approximately 5×10^{-6} μc. There is no upper limit of radioactivity measurement; the accuracy is better than ±1%. In connection with a standard the absolute error is approximately ±3%. (auth)

6444 MICROAUTOCLAVE FOR SYNTHESES WITH TRACER ELEMENTS. J. Wuersch (F. Hoffmann-La Roche and Co., A. G., Basel). Atompraxis, 7: 463-5(Dec. 1961). (In German)

A microautoclave of 6 ml capacity suitable for syntheses with tracer elements is described, and its usefulness demonstrated by a number of examples. (auth)

6445 THE RADIOCHEMISTRY OF ANTHRACENE SOLUTIONS IN AROMATIC HYDROCARBONS. W. Geiger (Farbenfabriken Bayer A. G., Wuppertal-Elberfeld, Ger.). Atompraxis, 7: 465-7(Dec. 1961). (In German)

Anthracene dissolved in aromatic hydrocarbons is decomposed chemically by the indirect radiation effect of high-energy gamma rays from a Co^{60} source. The anthracene concentration in an irradiated solution decreases in two ways: through the formation of dianthracene and through capture of radicals formed radiochemically from

the aromatic solvent; these enter the mesopositions of the anthracene. Dianthracene is formed by the transfer of electron excitation energy from the molecules of the aromatic solvent to dissolved anthracene molecules, followed by dimerization. G-values were determined for the decomposition of anthracene through dianthracene formation and through the capture of radicals. (auth)

6446 AN INDICATOR ACTIVATION METHOD. H. Glubrecht (Technische Hochschule, Hanover). Atompraxis, 7: 467-70(Dec. 1961). (In German)

In studying the diffusion of certain objects or substances it is possible to use suitable stable elements as indicators in place of radioactive isotopes, if these elements have a high activation cross section. The samples taken for demonstrating diffusion processes are activated in a nuclear reactor or with a particle accelerator and then measured. In general, this method is approximately as sensitive a means of demonstration as are those using radioactive indicators. Certain data for labeling waters with dysprosium, and fungus spores with manganese are given as examples. The method should prove equally useful in many other cases. (auth)

6447 POLYMERIZATION OF β-PROPIOLACTONE INITIATED BY γ IRRADIATION INTO THE SOLID PHASE. Bernard Tursch and Edith Tursch (Stanford Univ., Calif.). Bull. soc. Chim. Belges, 70: 585-91(Sept.-Oct. 1961). (In French)

The irradiation of β-propiolactone by the γ rays from Co^{60} to doses up to 4 Mr yields a crystalline polymer that is structurally a polyester. This polymer has a molecular weight of 4530 and a melting point of about 95°C. Other chemical and physical properties of the polymer are also given. (T.F.H.)

6448 RADIOMETRIC DETERMINATION OF THE SOLUBILITY PRODUCTS OF RUTHENIUM(IV) HYDROXIDE. J. Brandštetr, M. Křivánek, and J. Vřeštál (Brno Technical Univ. and "A. Zapotocky" Military Academy, Brno). Collection Czechoslov. Chem. Communs., 26: 2596-2601(Oct. 1961). (In German)

It was established radiometrically that in solutions of $Ru(OH)_4$ in very dilute acids the cation $(Ru(OH)_2)^{2+}$ was formed. For the solubility product of the hydroxide, the value of $4.9 \pm 1.2 \times 10^{-28}$, which corresponds to a solubility of 5.0×10^{-10} mole $RuO_2 \cdot nH_2$ in 1000 ml, was found. (tr-auth)

6449 STUDY OF ELECTRON MICROSCOPY OF THE SOLID STATE RADIOCHEMICAL POLYMERIZATION OF ACRYLIC AMIDE. Claude Sella and Jean-Jacques Trillat (C.N.R.S., Bellevue, France). Compt. rend., 253: 1511-13(Oct. 9, 1961). (In French)

X-ray diagrams of the radiochemical polymerization of solid-state acrylic amide have indicated that polymerization is not homogeneous in the crystal and that monomers and polymers form two separate phases. An electron microscopic study was made to clarify this hypothesis. The observation technique used permitted the phenomenon to be followed directly. The results showed well the heterogeneous character of the solid state polymerization with a very sharp separation of the two monomer-polymer phases. It is assumed that the beginning of the reaction is essentially connected to point faults and to dislocations which preexist in the monomer crystal, or which are created by the irradiation or by stresses and deformations which accompany the polymerization. Only the nucleation is controlled by the faults of the monomer crystal. The chain propagation, however, beginning from the nucleation continues at random at the polymer-monomer interface, which explains the globular form of the growing macromolecules and the absence of stereoregularity. (J.S.R.)

6450 THE INTERACTION OF SULFUR WITH RUBBER BY GAMMA IRRADIATION. B. A. Dogadkin, Z. N. Tarasova, M. S. Fogel'son, and A. I. Kashlinskii (Moscow Inst. of Fine Chemical Tech.). Doklady Akad. Nauk S.S.S.R., 141: 90-3(Nov. 1, 1961). (In Russian)

Since radiation vulcanization involves the interaction of free radicals, the reaction was followed by electron paramagnetic resonance on samples of rubber irradiated at 6 to 11×10^6 roentgens at +20 and −196°C. The irradiation of natural rubber and rubber containing 2% sulfur at 20°C leads to similar spectra with a concentration of free radicals of 1 to $2.5 \times 10^{14} mg^{-1}$. The radicals are very stable and show a concentration of 0.05 to $0.1 \times 10^{14} mg^{-1}$ at a period of 30 to 45 days after the irradiation. On irradiating at −196°C, short-lived radicals were observed in pure rubber that decompose on warming the sample at 20°C. The rate of disappearance of the short-lived radicals is particularly large at −80 to −50°C (the softening point of the rubber). The irradiation of rubber containing sulfur leads to the reaction of S_8 sulfur molecules with the rubber radicals and results in a more rigid structure for the rubber molecule (the amount of sulfur cross-linking is decreased). (TTT)

6451 EFFECTS OF γ RADIATION ON ACTIVITY OF PLATINUM CONTAINING CATALYSTS. Kh. M. Minachev and Yu. S. Khodakov (Zelinskii Inst. of Organic Chemistry, Academy of Sciences, USSR). Izvest. Akad. Nauk S.S.S.R., Otdel. Khim. Nauk, No. 8, 1430-2(Aug. 1961). (In Russian)

Effects of 0.6 Mev γ radiation on the activity of catalyst containing platinum black (1% Pt/Al_2O_3 and 10% Pt/Al_2O_3) were investigated. It is shown that radiation deactivation increases with increased platinum. The 1% Pt/Al_2O_3 catalyst, prepared by decomposing adsorbed H_2PtCl_6, exhibited no catalytic change under irradiation. (R.V.J.)

6452 CHEMICAL STATE OF RADIOPHOSPHORUS IN KCl CRYSTALS IRRADIATED BY HIGH ENERGY PROTONS. A. N. Murin, S. N. Banasevich, and R. V. Bogdanov (Khlopin Radium Inst., [USSR] and Leningrad State Univ.). Izvest. Akad. Nauk S.S.S.R., Otdel. Khim. Nauk, No. 8, 1433-7(Aug. 1961). (In Russian)

Low valence radiophosphors prevails in potassium chloride crystals irradiated with a total flux of $\sim 10^{12}$ to 10^{13} 660-Mev proton/cm^2. The oxidation of P^{32} passes through several stages during isothermal annealing of the irradiated crystals. The chemical transformations of P^{32} in irradiated KCl crystals result from radiophosphorus reaction with radiolysis products and disturbed centers. (R.V.J.)

6453 THE DISPERSION AND ELECTRICAL CHARACTERISTICS OF AEROSOLSO ORIGINATED BY RADIOLYSIS OF GASEOUS HYDROCARBONS. V. S. Bogdanov (Zelinskii Inst. of Organic Chemistry, Academy of Sciences, USSR). Izvest. Akad. Nauk S.S.S.R., Otdel. Khim. Nauk, No. 8, 1520-2(Aug. 1961). (In Russian)

Aerosols formed in radiochemical reactions consist of particles with a radius of 0.4 to 2 μ. Up to 80% of all charged particles are charged to magnitudes of 1 to 67 elementary charges. The results of charge measurements in methane, ethane, propane, n-butane, ethylene, and methane-oxygen and ethylene-oxygen mixtures are tabulated. (R.V.J.)

6454 STUDY BY ELECTRON PARAMAGNETIC RESONANCE OF ACETALDEHYDE IRRADIATED AT 77°K BY X AND γ RAYS. Claude Chachaty and Rose Marx (Faculté des Sciences, Orsay, France). J. chim. phys., 58: 787-9 (Sept. 1961). (In French)

The electron paramagnetic resonance of acetaldehyde irradiated at 77°K by x and γ rays is composed of a single ray and of a 5-ray spectrum attributed respectively to the radicals $RC(CH_3)\dot{O}H$ and $RO\dot{C}H(CH_3)$. On the contrary, the spectra of primary radicals from the radiolysis of this compound were not observed. (tr-auth)

6455 THE PHOTOLYSIS OF TRAPPED FREE RADICALS PRODUCED BY IONIZING RADIATION. Russell H. Johnsen (Florida State Univ., Tallahassee). J. Phys. Chem., 65: 2144-7 (Dec. 1961).

A study of the changes in yields resulting from the subsequent exposure of γ-irradiated alcohols to ultraviolet and visible light at −190° is reported. It is presumed that trapped free radicals are being photolyzed by this treatment. The chemical consequences thereof can be correlated with previously reported changes in esr spectra of γ-irradiated alcohols brought about by illumination with ultraviolet light. The study thus provides additional evidence as to the structure of the trapped radicals. (auth)

6456 IODINE CYANIDE AS A SCAVENGER IN THE RADIOLYSIS OF LIQUID BENZENE. Gordon Hughes (The University, Liverpool). J. Phys. Chem., 65: 2160-2 (Dec. 1961).

Decomposition yields in the radiolysis of benzene were measured using ICN as scavenger. The results are not readily explained in terms of free radical reactions only and indicate that processes of charge (or energy) transfer are taking place. (auth)

6457 EVIDENCE FOR TWO KINDS OF "H ATOMS" IN THE RADIATION CHEMISTRY OF WATER. E. Hayon and A. O. Allen (Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem., 65: 2181-5 (Dec. 1961). (BNL-5543)

Aqueous solutions of a number of chlorinated organic compounds, with concentrations and pH values varied over a wide range, were irradiated with γ rays. The main reduction products in every case were chloride ion and hydrogen gas. The chloride ion yield always predominated over that of hydrogen at high concentrations of solute or low concentrations of hydrogen ion, while hydrogen predominated in acid solutions at relatively low solute concentrations. The results suggest that the reducing radical, usually called "H," formed from the water by the radiation, reacts with these solutes mainly to form chloride ion; but it also can react with hydrogen ion to yield a different reducing radical, which reacts with the solutes to form hydrogen preferentially. Data obtained with chloroacetic acid solutions were sufficiently extensive to show good quantitative agreement with the competition kinetics suggested by this mechanism, and showed that "H" from water radiolysis reacts 3.4 times as fast with hydrogen ions as with chloroacetic acid molecules. (auth)

6458 THE REACTIVITY OF HYDROGEN ATOMS IN THE LIQUID PHASE: THE LACK OF EFFECT OF LINEAR ENERGY TRANSFER IN THE RADIOLYSIS OF HYDROCARBONS. W. G. Burns (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Phys. Chem., 65: 2261-2 (Dec. 1961).

Discussion is given on the two characteristics of the hydrogen yields from pure cyclohexane and pure n-hexane. The characteristics are the apparent lack of contribution to the hydrogen yield by the reaction $H + H \rightarrow H_2$ for radiation of low LET, and the invariance of the yields with changing LET of the radiation. Various works are reviewed, and it is suggested that a possible explanation of these effects is that the initial decomposition occurs at larger distances from the position of energy deposition than is sometimes supposed in models for the radiation chemistry of water. This may be the result of an intermolecular dispersal of energy, or a diffusion of molecules without decomposition (or possibly the latter following the former). (P.C.H)

6459 POLYMERIZATION OF SOLID ETHYLENE BY IONIZING RADIATION: EVIDENCE FOR ION-MOLECULE CONDENSATION. C. D. Wagner (Shell Development Co., Emeryville, Calif.). J. Phys. Chem., 65: 2276-7 (Dec. 1961).

Ethylene, irradiated at −196°C, was found to give low molecular weight, mostly branched polymers, 90% monoolefins, of carbon number through C_{18}. Products from the irradiation of an equimolar mixture of C_2D_4 and C_2H_4 were separated by gas chromatography, and mass spectra of the major C_4 (1-butene), C_6, C_8, and C_{10} components recorded. An initiating species with the formula C_2H_4 is believed to be the molecule ion, $C_2H_4^+$, or some excited state of the molecule. It is also felt that only the molecule ion could supply the driving force for carbon−carbon bond formation at such a low temperature. (P.C.H.)

6460 ELECTRON SPIN RESONANCE STUDIES OF IRRADIATED HIGH POLYMERS: POLYETHYLENE. Hisatsugu Kashiwabara (Japanese Assn. for Radiation Research on Polymers, Tokyo and Fuji Spinning Co., Tokyo). J. Phys. Soc. Japan, 16: 2494-2503 (Dec. 1961). (In English)

Molecular structures and the behaviors of the free radicals produced in irradiated polyethylene were investigated by means of electron spin resonance. ESR spectra of high polymers are, in general, so complicated that the identifications of hfs of the spectral patterns observed are difficult. Reasonable interpretations however, were made for polyethylene. Variations of spectral shape and spectral intensities with temperatures were discussed in connection with the identification of the free radicals produced and some of the irradiation effects in polyethylene. (auth)

6461 IRRADIATION EFFECTS ON CATALYST. Ellison H. Taylor (Oak Ridge National Lab., Tenn.). Nucleonics, 20: No. 1, 53-8 (Jan. 1962).

A review is given of the effects of radiation on catalysts using 24 articles as references. The following topics are briefly discussed: variation with catalysts and reaction, type of radiation, activation energy, annealing of defects, photoeffects on catalyst, poisoning, and radiation induced defects. The applications of irradiated catalysts are also discussed. (N.W.R.)

6462 A GRAPH-THEORETICAL TREATMENT OF ISOTOPE PRODUCTION. Herbert Izbicki (Osterreichische Studiengesellschaft fur Atomenergie GmbH, Vienna and Universität, Vienna). Nukleonik, 3: 309-12 (Dec. 1961). (In German)

A small demonstration with neutrons was set up so that a series of neutron captures and nuclear decay could occur. With the help of the graph theory a formula was stated for the number of the nucleus of an arbitrary resulting product after an irradiation time t. (tr-auth)

6463 THE CHEMISTRY OF NUCLEAR PROCESSES. IV. APPLICATION OF URANIUM FISSION TO THE SYNTHESIS OF CARRIER-FREE MOLYBDENUM HEXACARBONYL-(Mo^{99}). F. Baumgaertner and P. Reichold (Technische Hochschule, Munich). Z. Naturforsch., 16a: 945-8 (Sept. 1961). (In German)

Pure $Mo^{99}(CO)_6$ was produced free of other reaction products by nuclear fission in a mixture of $Cr(CO)_6$ and

U_3O_8 according to the reaction $Cr(CO)_6 + U(n,f)Mo^{99} \rightarrow Mo^{99}(CO)_6$. The relative yield ranged up to 60% and was equal to the yield we had found formerly for the production of $Ru^{103}(C_5H_5)_2$ by the same method. (auth)

6464 ELECTRON SPIN RESONANCE OF THE SULFUR IN IRRADIATED SULFHYDRYL COMPOUNDS AND THEIR DETECTABILITY IN THE LOW RADIATION DOSE RANGE. R. Koch and K. Markau (Universität, Freiburg i. B., and Institut für Elektrowerkstoffe, Freiburg i. B.). Z. Naturforsch., 16b: 586-8(Sept. 1961). (In German)

Sulfhydryl compounds (cysteine, homocysteine, 5-mercaptopyridoxine, or methionine) show different electron spin resonance spectra after irradiation. Using cysteine as an example, it was proved that radical concentrations could be determined after irradiation with 100 r. The significance of the observations in the biology of the primary radiation effect was discussed. (tr-auth)

6465 CHEMICAL EFFECTS OF NUCLEAR TRANSFORMATIONS. VOLUME I. Proceedings of the Symposium on Chemical Effects of Nuclear Transformations, Held in Prague, 24-27 October 1960. Proceedings Series. (International Atomic Energy Agency, Vienna). 1961. 578p. (STI/PUB/34(Vol.I)). $10.00(IAEA).

A total of forty-seven papers is included, for forty of which separate abstracts were prepared. Seven papers were previously abstracted in NSA; these concern theory of molecular dissociation by neutrons, thermochemical effects of ionizing radiation, beta-decay of He^6, transformation effects in polyvalent atoms, effects of thermal neutron capture and behavior of radiobromine from the (n,γ) reaction. (J.R.D.)

6466 THE CHEMICAL EFFECTS OF NUCLEAR TRANSFORMATIONS. A. G. Maddock (Cambridge Univ., Eng.). p.3-7 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

Aspects of nuclear transformations such as the primary events leading to bond rupture, recoil energies following radioactive thermal neutron capture, the Wilzbach labelling technique, and methods of assessing the effects of recoiling atoms by observations of radiolytic decomposition are discussed. The papers range from theoretical analyses to applied investigations. (J.R.D.)

6467 MECHANISMS OF MOLECULAR DISSOCIATION: DIATOMIC MOLECULES. J. L. Magee, K. Funabashi, and D. Mitchell (Univ. of Notre Dame, Ind.). p.11-23 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

Many of the chemical effects of nuclear transformation result from the action of radicals formed by molecular dissociation. Molecules which receive energy from particle impacts may be excited electronically or vibrationally. Either kind of excitation can lead to dissociation. High-velocity particles generally produce the former and low-velocity particles the latter type of excitation. A theoretical investigation of molecular dissociation caused by excess kinetic energy of constituent atoms is presented. Molecular dissociation resulting from high kinetic energy of one atom, and dissociation resulting from kinetic energy which is shared by at least several atoms before dissociation occurs were found. In the first case the atom with the high kinetic energy simply leaves the molecule with a trajectory which has no turning point; in the second case there is competition for the excess energy, at first by all degrees of freedom of the molecule, and later, as collisions occur, by all degrees of freedom of the entire system. Dissociation is only possible if it can occur with sufficient rapidity. These dissociation mechanisms were investigated with the help of several models of coupled atoms. Probabilities for dissociation as a function of excess energy were computed. The average energies required to produce dissociations were estimated. Theoretical and experimental results are compared. (auth)

6468 ATOMIC IONIZATION AND EXCITATION IN RECOIL PHENOMENA. M. Demeur (Université Libre, Brussels). p.41-4 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In French)

In studying the changing properties of the electronic shell of a recoiling atom, a good approximation may be obtained by considering separately the movement of the heavy and the light particles. Conventional methods are suitable for the former, but quantum mechanics must be used for the latter. The difficulties of evaluating the probabilities of interest to the experimenter derive mainly from definition of the wave functions by reference to one or more moving centers. For radioactivity (alpha or beta) and neutral recoil (gamma or neutron emission), the problem was solved by means of plausible approximations. Apparently, however, none of these methods could be used in studying the perturbation of the electronic shell during fission. A new method which embodies the earlier procedures and indicates a solution of the problem for fission is suggested. (auth)

6469 DISTRIBUTION IN KINETIC ENERGY OF DAUGHTER NUCLEI. H. C. Schweinler (Oak Ridge National Lab., Tenn.). p.63-72 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

Results are collected pertaining to the kinetic energy of the daughter nucleus immediately after each of several primary nuclear events. In some cases a fully quantitative expression is given, and in others only the probability distribution function for the kinetic energy is presented. For monoenergetic-neutron bombardment, results are presented for both spherically symmetrical scattering and the more general case characteristic of higher energy. For bombardment by neutrons with an energy distribution characteristic of nuclear reactors, the distribution function f(K) for initial kinetic energy K is approximately $f(K)\,dK = CK^{-1}\,dK$; corrections to and limitations of this formula are discussed. For monoenergetic, charged-particle bombardment, the low kinetic-energy transfers in particular are considered (Born approximation). The kinetic energy of the products is given for certain technically important (n,p) and (n,α) reactions, as well as for certain spontaneous (delayed) neutron and alpha-particle emissions. The kinetic-energy distribution follwoing capture gamma-ray emission subsequent to thermal-neutron capture is considered in some detail; results characteristic of several ranges of the mass of the daughter nucleus are presented, and the theoretical difficulties which prevent the formulation of a simple expression of widespread validity are discussed. Nevertheless, an expression for the average kinetic energy of recoil, $\overline{K} = 34000$ ev/An, is presented. (Here A is the atomic weight of the daughter nucleus and n is the number of capture gamma rays emitted.) Finally, the distribution of kinetic energy following beta-particle emission (both positive and negative) is considered. The allowed transitions are treated most thoroughly, and modifications of the results for forbidden transitions, and for the case of gamma rays accompanying the beta transformation, are also discussed. (auth)

6470 GAMMA-RAY DIFFRACTION BY RESONANT NUCLEI. G. T. Trammell (Oak Ridge National Lab., Tenn.). p. 75-85 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

The establishment by Mössbauer, and subsequently others, of an intense, non-Doppler broadened gamma-ray line produced by the decay of certain metastable nuclei in crystals affords a powerful tool for the investigation of a variety of chemical and solid state properties. In particular it gives the possibility of nuclear gamma-ray diffraction studies of substances containing the resonant nuclei. The nuclear elastic scattering cross section of the resonant radiation is of the order of $\lambda^2(\Gamma_{coh}/\Gamma)^2$, where Γ_{coh} is the partial width for gamma-radiation unaccompanied by phonon emission or absorption, and Γ is the total width of the excited nuclear level. For the 14.4 kev level of Fe^{57} this gives an elastic scattering cross-section of about 10^4b if the Fe^{57} nucleus is in an iron lattice at not too elevated temperature ($\Gamma_{coh}/\Gamma \doteq 0.05$). If the radiation is incident on a single crystal at a Bragg angle, the coherent radiation width is increased by a factor $(1 + 2\pi N_l\lambda^2 d^{-2})$, where d^{-2} is the density of the resonant nuclei in the scattering planes, and N_l is the number of scattering planes for the Bragg reflection involved. For a single crystal of Fe^{57} this would give a Lorentz line shape with approximately double the single nucleus width for the Bragg reflected intensity from a crystallite 10^3 layers thick. If the thickness were increased to about 10^4 layers, near total reflection would result at the Bragg angle. Separation of the nuclear from the electron scattering may be obtained in the usual way by a Doppler shift in the source or the absorber. Numerical estimates of resolution and intensity requirements for proposed experiments are presented. (auth)

6471 MASS-SPECTROMETRIC STUDIES OF NEGATIVE IONS WITH NEUTRAL MOLECULES. A. Henglein (Hahn-Meitner Institut für Kernforschung, Berlin) and G. A. Muccini. p.89-98 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

Various negative ion-molecule reactions were observed in gases of high electron affinity such as SO_2, I, NO_2, IBr, and CH_3NO_2. The primary ions are often formed by several electron resonance capture processes and therefore have several appearance potentials. These different potentials are known to correspond to different excitation levels of the neutral or negative fragments formed. The form of the ionization efficiency curves of the primary and secondary ions has been found to be identical in all cases. This indicates that the chemical reactivity of the primary negative ions does not depend on the specific capture process by which they are formed. The results show that certain negative ion-molecule reactions can occur with cross-sections of the order of 100 $Å^2$ and that they therefore cannot have any activation energy. Negative ion-molecule reactions may thus be possible in radiation chemical and hot-atom reactions. (auth)

6472 EXCITED ION REACTIONS IN N_2, O_2, CO, SO_2, CO_2, COS AND CS_2. V. Čermák and Z. Herman (Czechoslovak Academy of Sciences, Prague). p.99-102 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

Work with a mass spectrometer on molecule-ion reactions in mineral gases brought to light a number of new reactions characterized by the participation of the excited electronic states of ions, for example the states $B^2\Sigma_u^+$ of N_2^+ and $A^2\Pi_u$ of O_2^+. The new characteristic feature of these reactions is due to the fact that the primary ions react in a state with an average lifetime of the order of 10^{-7} to 10^{-6} sec. Since the residence of most of the excited ions in the source is very short owing to the emission of radiation, the secondary reaction actually occurs in the electron beam, and the thermal velocity of the primary ions is comparable to that acquired in the electric field. The consequences are discussed, and relations are given for calculating the approximate value of the reaction cross sections of the rate constants. (auth)

6473 REACTIONS OF POSITIVE IONS WITH MOLECULES IN THE GAS PHASE IN THE RANGE 3×10^{-2} – 10^{+2} eV. V. L. Tal'roze (Academy of Sciences, Moscow). p.103-12 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In Russian)

The results are given of research on chemical transformations occurring on the collision of ions with molecules as a result of the transfer of an electron or heavy particle. It is shown that in the process of charge exchange in polyatomic particles the transition from kinetic to excitation energy is greatly facilitated, which leads to considerable charge exchange cross sections of all slow ions (in the case of exothermic processes), and of ions with energies only slightly above the threshold (in the case of endothermic processes). Descriptions are given of two ion-molecule reaction mechanisms: with and without formation of long-lived intermediate ions. (auth)

6474 DISSOCIATION OF MOLECULES BY NUCLEAR DECAY OF CONSTITUENT ATOMS. S. Wexler (Argonne National Lab., Ill.). p.115-45 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

The patterns of positively-charged fragments, resulting directly from molecular dissociation due to beta-decay of tritium and of Br^{82}, and isomeric transition of Br^{80m} in various isolated molecules, were measured by mass-spectrometric techniques. In the beta transformation of organically-bound tritium to He^3, the C–He bond almost always ruptures, with the positive charge from the increase in nuclear charge going with the organic fragment. The organic fragment may dissociate further by C–C bond rupture and loss of neutral H and H_2, as shown by the large number of ions from C_2H_5T, p- and s-C_3H_7T, and o-, m-, p- and α-monotritiated toluenes. The similarity of the fragmentation patterns of the two isometric propanes and especially of the four isometric toluenes suggests that the influence of the location of the radioactive atom in the molecule on the dissociation following beta-decay is often obscured by secondary processes in the excited daughter before break-up. Principal differences in the propane spectra are consistent with greater stability of the secondary propyl structure relative to that of the primary isomer. Empirical estimates of the distributions of excitation energies made available to the daughter molecular ions $(C_2H_5He^3)^+$ and $(C_3H_7He^3)^+$ by the beta-transformation agree reasonably with expectations from the theoretical model based on perturbation of the electrostatic environment of the electronic cloud by the sudden change in nuclear charge. In the decay of TH and T_2, the respective $(HHe^3)^+$ and $(THe^3)^+$ daughters usually remain bound, but stability against dissociation depends slightly on the mass of the bonding partner. The behaviors of 1,2-$C_2H_4BrBr^{82}$ and CCl_3Br^{82} are in most respects similar to those of tritiated organic molecules. Nuclear internal conversion and subsequent Auger transitions in the isomeric transition of Br^{80m} in CH_3Br produces

a charged distribution ranging from Br^{1+} to Br^{13+} and peaked at Br^{7+}. The presence of singly, doubly, and triply charged C-containing fragments indicates that the CH_3Br^{80} daughter dissociates by Coulomb repulsion. The charge spectrum of Br from CCl_3Br^{80m} is also peaked; patterns of carbon and chlorine ions are observed. For $BrBr^{80m}$, the spectrum of charged bromines is peaked at Br^{5+}. (auth)

6475 TECHNIQUES OF RADIOACTIVE RECOIL SPECTROMETRY AND CHARGE SPECTROMETRY: THE ATOMIC CONSEQUENCES OF INTERNAL CONVERSION AND ELECTRON CAPTURE. A. H. Snell, F. Pleasonton, and T. A. Carlson (Oak Ridge National Lab., Tenn.). p.147-53 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

A survey of the techniques of radioactive recoil spectrometry is given whereby under collisionless conditions the ions resulting from beta-decay or internal conversion can be examined with respect to energy, charge, and mass. Experimental results are presented for Ar^{37} and He^6 as extreme examples in recoil energy spectra, and the atomic consequences of creation of a K-shell vacancy are illustrated in the charge spectra of $Ar^{37}-Cl^{37}$, $Kr^{79}-Br^{79}$, $Xe^{131m}-Xe^{131}$, and $Xe^{133}-Cs^{133}$. (auth)

6476 ELECTRON SHAKE-OFF FOLLOWING BETA-DECAY. T. A. Carlson, A. H. Snell, F. Pleasonton, and C. H. Johnson (Oak Ridge National Lab., Tenn.). p.155-60 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

After beta-decay an atom may be left in a sufficiently excited state to lose one or more of its orbital electrons. To study this phenomenon various radioactive rare gases were allowed to decay in a specially designed mass spectrometer, and the resulting ions were collected and analyzed. Data on the following isotopes were obtained: He^6, Ar^{39}, Kr^{79}, Kr^{85}, Xe^{133}, and will soon be available for Ne^{23} and Ar^{41}. The charge-spectra of the various rare gases are compared as a function of their atomic number and in accordance with whether decay proceeds by β^- or β^+. An attempt is made to explain the data in terms of initial excitation arising from the sudden non-adiabatic change in nuclear charge, accompanied by subsequent Auger processes in cases where inner orbital electrons are removed. Various shake-off theories are evaluated, and it is of particular interest to note the good agreement between the experimental results for He^6 with the quantum mechanical calculations made by Winther. (auth)

6477 NEUTRON IRRADIATION OF ARSENIC TRICHLORIDE–BENZENE SYSTEMS. I. Tsifka (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Prague). p.185-93 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In Russian)

A study was made of the distribution of As^{76} between total inorganic arsenic, phenyl- and diphenyl arsine derivatives in pile neutron-irradiated samples of arsenic trichloride in benzene. Experiments were carried out at neutron fluxes of 10^{10}, 10^{11}, and 10^{13} n/cm^2 sec respectively. Paper chromatography and/or precipitation were used as methods of separation. The influence of elemental iodine on the yield of the chemical forms mentioned above was investigated in order to obtain more detailed information concerning the reaction mechanism under study. The yield of As^{76} as phenyl arsenic decreases rapidly with increasing concentration of $AsCl_3$. It was found that a small fraction of phenyl arsenic is formed as a consequence of radiation changes. The presence of elemental iodine diminishes the yield of diphenyl arsenic compounds. $AsCl_3$ acts as a radical scavenger. This was demonstrated by irradiation at a neutron flux of the order of 10^{13} n/cm^2 sec. It was found that under identical irradiation conditions and until $AsCl_3$ reaches low concentration most of the As^{76} remains bound in polymeric compounds formed by the radiolysis of benzene. (auth)

6478 THERMAL-NEUTRON IRRADIATION OF TRIMETHYL– AND TRIPHENYLPHOSPHINE. M. Halmann (Weizmann Inst. of Science, Rehovoth, Israel). p.195-202 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (BNL-4878). (In English)

The Szilard-Chalmers reaction in organic phosphorus compounds was previously described only in the liquid or solid phase, in which it is difficult to recognize the primary products of the P^{32} atoms recoiling after neutron capture in the presence of many secondary products. An investigation is reported in which trimethylphosphine was chosen as a volatile compound that could be separated from phosphine and from other methylphosphines by gas chromatography. Trimethylphosphine was irradiated in quartz ampoules in the Brookhaven reactor. The volatile products were separated through a column of silicone oil on firebrick. The activity deposited on the walls of the ampoules was washed off with aqueous acid and analyzed by paper electrophoresis. Among the volatile products, most of the radioactivity was found in phosphine. After thermal-column irradiation (5.7×10^8 n/cm^2 sec), the phosphine contained 40% of the total activity. At 5.2×10^{12} n/cm^2 sec its yield decreased, while the activity on the walls increased correspondingly. This is explained as radiolysis of phosphine. The activity of the other volatile products was: $MePH_2$, 1–3%, Me_2PH, 0.3%; Me_3P, 0.6–3.8%. The activity in trimethylphosphine decreased with lowered pressure. This demonstrates that there is no appreciable retention of chemical bonds of the recoiling phosphorus atom. Triphenylphosphine was irradiated under vacuum in the Harwell pile at 2×10^{11} n/cm^2 sec. Active products were separated by liquid extractions. The activity of triphenylphosphine was 2–3% of the total, while larger fractions appeared in various phenyl- and inorganic acids of phosphorus. (auth)

6479 SZILARD-CHALMERS PROCESSES IN CHLOROCARBONS. A. H. W. Aten, Jr. and J. G. van Raaphorst (Instituut voor Kernphysisch Onderzoek, Amsterdam). p.203-8 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

During recent years work was done on the reactions occurring between hot tritium recoil atoms and hydrocarbons. It would be of interest to investigate similar systems consisting of a pair of atoms, different from the H–C combination. The choice is extremely limited as most elements form only a very few compounds with carbon. The combination of C with Cl is very tempting in this respect and a number of preliminary irradiations of simple chlorocarbons were performed with slow neutrons. Although the analysis of the products presents formidable problems the results obtained indicate that the reactions which take place are similar in general to those observed with tritium atoms and hydrocarbons. (auth)

6480 CHEMICAL EFFECTS OF NUCLEAR TRANSFORMATIONS OF HALOGEN ATOMS IN ORGANIC HALIDES. J. E. Willard (Univ. of Wisconsin, Madison).

p.215-27 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

Current knowledge of the chemical effects of radiative neutron capture in gaseous, liquid and solid organic halides is summarized. The extent to which the mechanisms of observed effects are understood is evaluated and those phenomena which are most in need of further study are pointed out. Topics considered include the multiplicity of products formed in all phases; the similarity of the products and yields for activation by isomeric transition, as compared with activation by radiative neutron capture; the scavenger effect in liquid organic bromides and iodides; the absence of scavenger effect in hydrogenous organic chlorides; the enhancement of organic yields by dilution with hydrocarbons; the effects of temperature and of the chain length of organic solvents on the organic yields of iodine and bromine in hydrocarbon solution; possible isotope effects and neutron energy effects; organic yields in the solid phase as compared with the liquid phase; the effects of radiolysis products formed by the gamma-radiation which is associated with neutron irradiations; the distribution of products containing Br^{82} following radiative neutron capture by Br_2 in fluorobenzene, chlorobenzene and bromobenzene; and the fate of I^{131} in iodobenzene. Unique gas-phase displacement reactions between organic molecules and halogen atoms or ions activated by radiative neutron capture are discussed. New observations on the effects of temperature, gamma radiation exposure and annealing in solid organic bromides are presented. (auth)

6481 CHEMICAL EFFECTS OF THERMAL-NEUTRON IRRADIATION OF BROMOALKANES. W. E. Harris (Univ. of Alberta, Edmonton). p.229-44 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

A review of studies of the chemical consequences of radioactivating Br in the four isomeric monobromobutanes, monobromoethane and the bromomethanes is presented. The tendency of bromoalkanes to react under the influence of neutron irradiation to give radiobromine-containing compounds with more C atoms than the parent molecule was determined. Irradiation of mono-, di- and tribromomethane produced radiobromine-containing products which included 3%, 6%, and 10% of bromoethanes, whereas no hexa bromoethane was recovered from the irradiation of tetrabromomethane. Evidence for bromochloroethanes was obtained from irradiated bromine/carbon tetrachloride mixtures. No bromopropanes or bromobutanes containing radiobromine could be identified among the organic products from the irradiation of bromoethane. The effect of relatively large amounts of Br scavenger on the reactions was also determined. Examination of the products obtained from the neutron irradiation of bromine-bromoalkane mixtures indicated that three distinct types of reactions are important in their formation. In addition to the diffusive and hot reactions which were described previously, a third type, designated as hot-spot diffusive, is postulated, The evidence for, and a means of estimating, the amounts of products resulting from these three types of reaction are discussed. Radiobromine-containing products from the four isomeric monobromobutanes were examined. Isomerization which involves only the shift of the Br atom was observed. In addition, chain isomerization was also observed. This unexpected result is discussed along with other noteworthy aspects of the data. (auth)

6482 A STUDY OF THE INDIVIDUAL ORGANIC HALOGEN RECOIL PRODUCTS IN LIQUID ALKYL CHLORIDES, BROMIDES AND IODIDES, WITH SPECIAL REFERENCE TO THE INFLUENCE OF AMINE SCAVENGERS. G. Stoecklin, F. Schmidt-Bleek, and W. Herr (Max-Planck-Institut für Chemie, Mainz and Kernforschungsanlage, Jülich, Ger.). p.245-58 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

The organic recoil products of the $Cl^{37}(n,\gamma)Cl^{38}$, $Br^{79}(n,\gamma)Br^{80}$, and $I^{127}(n,\gamma)I^{128}$ process in liquid alkyl halides were investigated gas-chromatographically. The identification of the fractions was carried out with known carriers. The influence of increasing gamma-doses on the total retentions of the three neutron-irradiated alkyl halides was investigated first. Two different isomerization effects due to the accompanying gamma-radiation were observed: the isomerization of n-propyl chloride to iso-propyl chloride and the isomerization of iso-propyl bromide to n-propyl bromide. A comparison of the individual recoil products from the three n-propyl halides shows that the percentage of the total retention as the parent material is 32 for $n\text{-}C_3H_7Cl$, 62 for $n\text{-}C_3H_7Br$, and 89 for $n\text{-}C_3H_7I$. Virtually no di-iodides (traces of 0.3% only) and no higher homologues could be detected gas-chromatographically in the $n\text{-}C_3H_7I$ system. Regarding the disappearance of dibromides when secondary or tertiary amines are added as scavengers it is probable that one-step replacement reactions will not lead to the formation of dihalides in the alkyl halide systems. Reactions of the thermal-recoil halogen atoms with the solvent molecules, however, should mainly contribute to the formation of dihalides and higher homologues. Since activation energies increase from chlorine to iodine, recombination reactions become more important for the latter and they lead mainly to the formation of labelled parent molecules. Structural effects with growing carbon chain length were also studied. The retention increases with increasing chain length up to $n\text{-}C_5H_{11}Br$, but the percentage retention as parent compound remains fairly constant. Finally, the effect of different amine scavengers on the alkyl halides was investigated. Whether an amine scavenger leads to an increase or decrease of retention (or has no effect) depends on the irradiated system. A remarkable increase in the retention (up to 100%) is effected by the addition of tertiary amines, and especially by quaternary alkyl ammonium halides and other onium salts. The possible reaction-mechanisms are discussed. (auth)

6483 ISOTOPE EFFECT AND SECONDARY REACTIONS OF BROMINE RECOIL ATOMS ACCOMPANYING THE (n,γ) PROCESS. A. N. Nesmeyanov, E. S. Filatov, E. A. Borisov, and B. M. Shukla (Academy of Sciences, Moscow). p.259-76 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In Russian)

The objects of the investigation were to determine the applicability limits of the elastic collisions theory in the case of Br derivatives of methane; to ascertain the mechanism governing the formation of parent compounds; to investigate the formation of substitution products of H, Cl, and F; and to determine the differences in behavior of Br isotopes in the (n,γ)-activated process. Results of a study of the temperature-dependence of secondary reactions of recoil atoms of Br^{82}, Br^{80m}, and Br^{80} in the liquid phase in the compounds $CHBr_3$, CH_2Br_2, CH_2ClBr, $CHCl_2Br$, CCl_3Br, CCl_2Br_2, $CHClBr_2$, CH_2BrI, CBr_3F, $CHBr_2F$, and the results of a study on recoil atoms of Br in the solid phase in these compounds are presented. Investigations on the liquid and solid phases were also carried out to determine the effect of the aggregate state on the yields of organic compounds

obtained by activation, and to study the effect of phase on a possible isotope effect. The temperature-dependence and the phase-effect of occlusion were obtained by integrating between +80 and −196°C. Irradiation was performed with a Po−Be source at an integral intensity of 3×10^7 n/sec. It is shown that in the solid phase there is no isotopic difference in any of the compounds investigated. The isotope effect in the liquid phase is explained on the hypothesis that ion-molecule reactions take place in the sub-thermal energy region. It is shown that as a result of diffusion processes recoil atoms will also form molecules of parent compounds. An explanation of the mechanism of their formation is suggested. (auth)

6484 RECOIL STUDIES IN MIXED ALKYL IODIDES. R. M. Iyer and G. Martin (Univ. of Durham, Eng.). p.281-7 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

Radiochemical studies were made of the fates of iodine atoms recoiling, as the result of nuclear reactions, in mixtures of alkyl iodides (especially methyl and propyl iodides). Particular attention was focused upon mixtures in which one only of the components contained the long-lived I^{129} (1.72×10^7 yr half-life), so that it was possible to fix unequivocally the origin of the recoil I found in the products. Techniques were developed for the synthesis of methyl and propyl iodides, labeled with I^{129}, on a microscale, and for the separation, after irradiation, of the various products. To explain the observed distribution of products, it is apparently necessary to invoke two separate effects: (a) a recoiling iodine atom is more likely (by a factor of about two or three, depending upon the conditions) to appear as methyl rather than as propyl iodide (for equal molar concentrations); and (b) about 10% of the neutron captures in I^{129} either do not result in bond rupture at all, or, if they do, lead to an immediate recombination with the organic residue of the parent molecule. (auth)

6485 THE SIGNIFICANCE OF TIME-DEPENDENCE IN ASSESSING THE RESULTS OF EXPERIMENTAL MEASUREMENTS IN HOT-ATOM CHEMISTRY AND THEIR THEORETICAL INTERPRETATION. K. Svoboda (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Prague). p.289-96 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In Russian)

Hot-atom chemistry has reached a stage at which the transition from particular theories, valid only for individual cases, to general theories, valid for a large number of systems, has become necessary. In attempting to derive expressions which are generally applicable from data obtained in experiments performed on a small number of systems it is necessary to make sure that the reactions which led to a given product are properly understood and that hot-atom reactions are distinguished from side reactions. The dependence of the yield of a product on the duration of the irradiation can serve as a useful criterion in evaluating the relative roles which hot atom reactions and various secondary and side reactions play in the formation of a product. Several examples are given for the application of this method of evaluation to experimentally obtained data. (auth)

6486 RECOIL ATOM REACTIONS AND POST-IRRADIATION EFFECTS IN CRYSTALLINE COBALTAMMINE SALTS. G[arman] Harbottle (Brookhaven National Lab., Upton, N. Y.). p.301-7 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (BNL-4897) (In English)

Recoil reactions of Co were examined in a series of cobalt hexammine and mono-substituted cobale pentammine salts. In the case of cobalt hexammine nitrate irradiated with neutrons, Co^{60} recoils are found in the chemical form of the parent, of cobalt aquopentammine, nitropentammine, and nitropentammine complex ions, and as cobaltous ion, following dissolution in water. Paper electrophoresis was used as a means of separation. Samples of these irradiated complexes were annealed at 83°C and then analyzed; results are included. (auth)

6487 RECOIL EFFECTS OF Co^{60} IN THE (n,γ) REACTION IN TRIS-ACETYLACETONE Co(III). J. Shankar, K. S. Venkateswarlu, and A. Nath (Atomic Energy Establishment, Trombay, India). p.309-33 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

The kinetic aspects of the annealing of the recoil species in thermal-neutron irradiated octahedral cobalt complexes show distinct resemblances to the annealing of radiation damage in metals, semiconductors, etc. The fragments formed in (n,γ) reactions are, however, more complex and the chemical and stereochemical factors play important roles in the annealing process. In tris-acetylacetone Co(III), the increase in retention on heating of neutron-irradiated samples follows apparently a first-order rate law. The plot of log k against 1/T is not a straight line, showing that there is a spectrum of activation energies and frequency factors of the principal annealing process. The logarithm of the frequency factor increases linearly with increasing activation energy. A faster annealing component is also observed and its rate is nearly independent of the temperature in the range studied. The kinetic data for the temperature-dependent component are analyzed in terms of different concepts. Analysis by Vand-Primak methods gives a spread in activation energy with the peak at ~1.27 ev. Experiments with pulse annealing also indicate a spread in the activation energy. In multi-stage annealing experiments, the R_∞ values are lower and the annealing rates decrease as compared to single-stage runs. The activation-energy spectrum shifts to higher values in the second-stage annealing run. Gamma-irradiation of the neutron-irradiated tris-acetylacetone Co(III) results in an increase in initial retention. The R_∞ values and the annealing rates decrease as compared to those of simple neutron-irradiated samples. The activation-energy spectrum shifts to higher values. In relation to the annealing process gamma-irradiation appears to correspond to the first-stage thermal annealing in multi-stage experiments. In the sample annealed at room temperature for over two years, gamma-radiation regenerates the faster component whose annealing rate is practically independent of temperature. (auth)

6488 BEHAVIOUR OF RECOIL COBALT ATOMS RESULTING FROM (γ,n) AND (n,2n) REACTIONS IN COBALT COMPLEXES. A. Nath (Moscow State Univ.). p.335-42 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

The thermal annealing of the damage caused by (γ,n) and (n,2n) reactions was investigated for several cobalt complexes in the solid phase. Solvent extraction and ion-exchange methods were employed in the determination of the chemical distribution of the Co^{58}-activity. The results are compared with those obtained earlier for (n,γ) reactions. (auth)

6489 THE SZILARD-CHALMERS PROCESS IN SOLID INORGANIC COMPOUNDS OF IRIDIUM AND OSMIUM.

K. Heine (Universität, Cologne) and W. Herr. p.343-54 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

Thermal-neutron capture in the alkali salts of the hexachloro and hexabromo complexes of Ir and Os produces several recoil species which may be distinguished by paper-electrophoresis. In order to obtain reproducible results, attention must be paid to certain experimental conditions. Complications may also arise from uncontrolled hydrolysis of the hexachloro and hexabromo compounds. It can, however, be proved that under proper experimental conditions hydrolysis is not serious. The qualitative and quantitative distribution of the separated recoil fragments varies widely for the same anion, if the cation is changed. The reason for this behavior is investigated. Heating of the neutron-irradiated crystals results in thermal annealing of the recoil fragments. The behavior of Ir^{192}, Os^{191}, and Br^{82} recoil atoms was investigated by paper-electrophoresis and conventional precipitation methods. In some cases a temperature-independent value for R_∞ was observed. The results are discussed in the light of current theories. The distribution and the annealing behavior of the Br^{82} recoil atoms in these salts is investigated and discussed. (auth)

6490 THE RETENTION OF CONFIGURATION IN THE SZILARD-CHALMERS REACTION IN SOLIDS. A. V. Zuber, H. B. Rauscher, J. M. Miller, and N. Sutin (Brookhaven National Lab., Upton, N. Y. and Columbia Univ., New York). p.359-64 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (BNL-4889) (In English)

The Szilard-Chalmers reactions in dextro-tris-(ethylenediamine) cobalt(III) nitrate and in cis- and trans-dichlorobis-(ethylenediamine) cobalt(III) nitrate were investigated. The percentage of the total Co^{60}-activity found in the form of the parent compound ranged from 4 to 8% in all the compounds studied. When a given isomeric form was irradiated, a negligible amount of activity was found as the other isomer. Although the percentage of the total activity in the form of the parent compound increased on annealing the irradiated solids, the isomeric specificity persisted. A similar isomeric specificity was exhibited by the Cl^{38}. On prolonged annealing of the irradiated solids, the activity in the form of the parent compound appeared to reach a temperature-dependent limiting value. On annealing at 100°C this value, reached after several hours, was 52% for the Co^{60}-activity and 65% for the Cl^{38}-activity. The time and the temperature dependence of the annealing process suggest a phenomenological description in terms of competitive first-order reactions. An analysis of the data indicates that the processes occurring during the isothermal annealing differ markedly from those which occur during the lifetime of the hot zone. (auth)

6491 RADIATION-ANNEALING OF CIS AND TRANS ISOMERS OF SOME 6-CO-ORDINATE COBALT COMPLEXES. P. Dimotakis (Greek Atomic Energy Commission, Athens) and A. G. Maddock. p.365-71 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

The kinetic characteristics of radiation annealing of recoil damage were shown to be simpler than those of thermal annealing. It was suggested that the mechanism of the two processes might be fundamentally different. Radiation annealing might take place by dissociation of an inactive molecule or molecular ion near to an active fragment, followed by reformation of the molecule incorporating the radioactive fragment: a process that might be described as a radiation-activated exchange process involving the recoil fragments. Thermal annealing of neutron-irradiated cis and trans isomers was shown to lead predominantly to reformation of molecules possessing the original configuration. The radiation-activated exchange model for radiation-annealing hardly seems likely to lead to retention of configuration in the reconstituted molecules. An investigation in which the distribution of activity between the cis and trans forms, as well as the reduced state, were measured is reported for a number of neutron-irradiated cis and trans cobalt complexes after varying periods of annealing by ionizing radiation. Some combinations of thermal and radiation annealing were also explored. The results are discussed in terms of current models for the annealing reactions. (auth)

6492 RECOIL EFFECTS OF Co^{60} IN (n,γ) REACTIONS IN POTASSIUM TRIS-OXALATO Co(III) AND TRIS-OXINE Co(III). J. Shankar, V. G. Thomas, and A. Nath (Atomic Energy Establishment, Trombay, India). p.383-91 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

An attempt is made to distinguish the recoil species containing the Co^{60} atoms, in neutron-irradiated potassium tris-oxalato Co(III) and tris-oxine Co(III). Ion-exchange and solvent-extraction methods were employed. In the case of the tris-oxalato complex, both methods give the same value for retention (R) indicating that only two species can be present. In the case of the oxine complex however, the solvent-extraction values are different from those obtained by the ion-exchange method, indicating the presence of more than two species containing Co^{60}. An investigation of the kinetics of the isothermal annealing of the recoil species in the oxalato complex reveals the process to be first order with an activation energy of the order of 1.4 ev. The R_∞ values at different temperatures converge at the same point. In the oxine chelate the kinetics appear to be complex. (auth)

6493 RECOIL EFFECTS OF Co^{60} IN (n,γ) REACTIONS IN TRIS-GLYCINE Co(III) AND SODIUM ETHYLENEDIAMINE TETRA-ACETATO Co(III). J. Shankar, S. B. Srivastava, and R. Shanker (Atomic Energy Establishment, Trombay, India). p.393-408 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

Work on tris-glycine Co(III) is an extension of that already reported. The activation energy of all the individual component reactions determined by the analysis of the over-all log $(R_\infty - R)$ against time plots was found to be nearly same. The electrochromatographic separation technique used on the neutron-irradiated complex indicates that there are only two recoil fragments. The data indicate that there is perhaps only one species involved in the annealing process. The data have also been analyzed on the basis of the Vand-Primak technique. Dilution by methyl methacrylate and the effect of the length of the ligand chain on the initial retention and subsequent post-irradiation annealing were studied in the case of tris-glycine Co(III). Very low initial retention values characterized by little annealing were observed. Sodium bis-glycyl glycine Co(III) hydrate and sodium ethylene-diamine tetra-acetato Co(III) irradiated at an integrated neutron flux of $\sim 1 \times 10^{17}$ n/cm^2 and $\sim 3 \times 10^{16}$ n/cm^2 respectively were also examined. The electrochromatogram in the former case confirms the presence of only two fractions while in the latter case a rather complex composition is observed. X-ray diffraction

studies on irradiated and unirradiated tris-glycine Co(III) and Co(III) EDTA are also described. The results show certain interesting changes in the powder patterns, which are discussed. (auth)

6494 STUDY OF THE SZILARD-CHALMERS REACTION IN "OPEN-TYPE" COMPLEXES OF COBALT. A. Nath and J. Shankar (Atomic Energy Establishment, Trombay, India). p.409-15 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

The thermal-annealing behavior of several neutron-irradiated Co complexes in the solid state was examined. On the basis of the results obtained, the metal chelates can be roughly classified into categories including a group characterized by a relatively low value of original retention, which shows little change on subsequent thermal treatment or x- and gamma-irradiation, and a group characterized by a relatively higher value of original retention which exhibits a fairly large increase on heating or x- and gamma-irradiation. Results obtained on complexes of first category are discussed. (auth)

6495 RECOIL EFFECTS OF Co^{60} IN (n,γ) REACTIONS IN TRISACETYLACETONE Co(III) DILUTED WITH ALUMINIUM ACETYLACETONATE. J. Shankar, K. S. Venkateswarlu, and M. Lal (Atomic Energy Establishment, Trombay, India). p.417-25 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

Szilard-Chalmers reactions in chromate, and permanganate ions diluted with other similar ions (sulfate, fluoberyllate, and perchlorate) indicate a change in the initial retention and in the annealing behavior, as compared with the pure samples. Some studies on the (n,γ) reaction in tris-acetylacetone Co(III) diluted with the isomorphous aluminum acetylacetonate, which reveal interesting features, are reported. The initial retention and R_∞ values are found to decrease with increasing dilution. However, the annealing rates are observed to be faster as compared with the pure sample. On dilution, the activation-energy spectrum shows a broad shift to lower values. The faster annealing components are not in evidence in the second stage of the two-stage annealing experiments. (auth)

6496 CHEMICAL CONSEQUENCES OF NUCLEAR RECOIL IN SOLIDS: ISOTOPIC, STERIC AND ANNEALING EFFECTS IN COBALT, COPPER AND ZINC PHTHALOCYANINES. D. J. Apers and P. C. Capron (Institut Interuniversitaire des Sciences Nucléaires, Brussels and Université, Louvain, Belg.). p.429-46 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

The liberation of metal following radiative neutron-capture in phthalocyanines was re-examined. Particular care was taken in the preparation of very pure compounds and a new method of purification was evolved. After fusion of the phthalonitrile in the presence of metal, the excess of organic compounds is extracted with benzene. Phthalocyanine itself is then extracted with pyridine, forming a complex with two molecules of the solvent. This complex is destroyed by sublimation in vacuo. In this way the finite material contains no traces of unreacted metal. Retentions were measured in free cobalt, copper, and zince phthalocyanines and in the pyridine complexes. The retention is undoubtedly lower in the latter category. This appears to indicate that the metallic atom ejected from its molecule during the capture process recombines less readily as the steric hindrance increases. This implies that the recoil distance must be large by comparison with the size of the phthalocyanine molecule. An order of magnitude is given for the enrichment factors and discussed as a function of the separation procedure. The retention of Zn^{69} in phthalocyanines is much greater than the retention of Zn^{65}, suggesting marked differences in the recoil energies of the two isotopes, or in their excitation states. This is confirmed by thermal annealing experiments. Part of the Zn^{69} recombines to the initial molecule under the action of heat, yielding the usual annealing curves. Zn^{65} is not affected by temperature increases and its retention remains unchanged in both pure zinc phthalocyanine and the pyridine complexes. Zinc phthalocyanine which has been irradiated with neutrons is insensitive to the action of energetic electrons from a linear accelerator. Several interpretations are reviewed and discussed. (auth)

6497 APPROXIMATE METHODS FOR TREATING ANNEALING PROCESSES WHICH INVOLVE A SPECTRUM OF ACTIVATION ENERGIES. D. K. Holmes (Oak Ridge National Lab., Tenn.). p.449-61 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

Many experiments involving the annealing of the effects of radiation damage to solids showed that the underlying processes are complex. In general, this may be attributed to two different fundamental causes. The first is that the processes may be of higher order than the first. For example, in radiation damage involving displaced atoms, either from elastic collisions with fast particles or recoil from the emission of radiation by an unstable nucleus, second-order annealing would be expected in cases in which the property changes observed depend on both the vacant lattice site and the interstitial atom and in which the recovery depends on the recombination of these two defects. However, the second basic reason for complication of the annealing will be of greatest interest here. It is possible that the basic process may not be simply activated; i.e., the critical step in the recovery of the lattice may not depend on a unique activation energy. For example, an interstitial atom might be bound to an impurity atom in the lattice; but the value of the binding energy could depend slightly on just how close the interstitial is to the impurity atom, or in just which of the different, non-lattice positions near the impurity the interstitial is found. In the treatment, it is basically assumed that the observed annealing results from basic processes which have a continuous spectrum of activation energies but all of which are kinetically of first order and independent. On the basis of the treatment, it is possible to obtain an approximation to the spectrum of energies from isothermal annealing data. The accruacy of the method is limited by the fact that the spectrum cannot be determined more closely in energy than one or two kT units. Further limitation is that the method requires taking derivatives of the experimental data, which magnifies the experimental errors. On the basis of this model, several different types of actual annealing studies are analyzed. The case of diffusion-limited annealing requires special attention. (auth)

6498 ACTIVATED EXCHANGE ON INORGANIC CRYSTALS. S. R. Veljković (Univ. of Belgrade), J. V. Stevović, and O. I. Mićić. p.465-72 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

Exchange of phosphate ions on various crystalline surfaces (salts, oxides) was studied. Ions were either adsorbed or built in the structural lattice of the solid phase. The kinetics of the component processes, such as physical adsorption, chemisorption and diffusional interchange, could be dinstinguished, by the study of temperature, concentra-

tion and time effects. The modification of the thermal kinetics by the specific increase of energy content in the systems studied above is of interest. The authors explored the contribution of the activation of the solid phase, by in-pile irradiation, by formation of excited species by (n,γ) nuclear transformations, by treatment with ionizing radiation and by extensive thermal treatment. A discussion of the kinetics of the heterogeneous reactions under conditions involving hot processes is given. (auth)

6499 ON THE CHEMICAL BEHAVIOUR OF P^{32} RECOILS IN INORGANIC CRYSTALLINE PHOSPHORUS COMPOUNDS. L. Lindner and G[arman] Harbottle (Brookhaven National Lab., Upton, N. Y.). p.485-502 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (BNL-4958). (In English)

The chemical behavior of recoil P in inorganic crystalline systems was repeatedly investigated. Considerable discrepancies, however, exist between the results of various workers. The authors have recently been engaged in an extensive study of P^{32} recoil reactions in a number of crystalline inorganic phosphorus compounds. Paper-electrophoresis techniques were employed to achieve a separation of a great variety of product species. Several of these species have been tentatively determined as being oxy-anions of phosphorus containing one, two or three phosphorus atoms. The distribution of P^{32} recoils among the product species appeared to be critically dependent upon the irradiation conditions. The P^{32} recoil reactions have been studied as a function of radiation and thermal environment, i.e. temperature of bombardment, neutron-flux: gamma ratio as well as annealing conditions and crystalline environment. The maximum probability of non-bond-rupture in crystalline phosphates is probably not greater than 10% and may well be lower. (auth)

6500 CHEMICAL EFFECTS PRODUCED BY THE NEUTRON-IRRADIATION OF PHOSPHORUS COMPOUNDS. T. R. Sato and H. H. Strain (Argonne National Lab., Ill.). p.503-16 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

The chemical effects produced by the action of neutrons upon phosphine, various oxyacids of phosphorus, and salts of these acids were studied. With differential electrical migration (electro-chromatography) in moist paper and mass spectrometry, activation products were separated and identified. To distinguish among the conditions that affect the phosphorus compounds, the temperature produced by neutron-irradiation of the containers and the phosphorus compounds themselves were measured. The chemical effects produced by heat and gamma-rays, were estimated and the neutron-activation products containing P^{32} were calculated. Phosphine and certain oxyacids with P-H bonds were altered by gamma-rays and by neutron activation and yielded various disruption products. Radioactive phosphorus (P^{32}) was found both in the disruption products and in the irradiated species; but many other oxyacids and their seals were remarkably resistant both to gamma- and neutron-irradiation, virtually all the radioactivity residing in the species exposed to neutrons. These chemically resistant substances were orthophosphoric acid, its primary, secondary and tertiary salts, its linear condensation products such as pyrophosphoric acid and its salts, and the cyclic condensation product trimetaphosphoric acid and its salts. In all these compounds, fully oxidized atoms of phosphorus are surrounded by single and double linkages with oxygen. Were these complex oxyacids ruptured upon neutron-activation, the fragments with radioactive phosphorus should not reform the same chemical species as that which was irradiated. Chemical analysis indicates, therefore, that these P compounds are not ruptured upon neutron-activation. They resist the disruptive action of the emission of the neutron-binding energy even though this energy exceeds by several magnitudes the heat of formation of the irradiated compound. Primary and secondary phosphates which are easily condensed to pyrophosphate by heat (250–350°C) were not condensed to pyrophosphate by neutron-activation. The explanation of these observations lies in the great chemical stability of the P—O and P=O bonds and the phosphate group, in the lability of the P—H bond, and in a mechanism for the dissemination of the neutron-binding energy without cataclysmic chemical decomposition. (auth)

6501 THE EFFECT OF PHASE CHANGES ON THE ANNEALING BEHAVIOUR OF NEUTRON-IRRADIATED CRYSTALS. H. Mueller (Universität, Freiburg i. B.). p.521-6 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

According to the Harbottle-Sutin model, the annealing of Szilard-Chalmers systems is caused by a thermally-induced recrystallization of displacement spikes. Such recrystallization should also occur if the matrix lattice undergoes a phase change. If the transition has really taken place, the observable increase in retention should be constant for all temperatures. Such behavior was in fact observed when calcium bromate monohydrate was dehydrated. However, these experiments do not provide unequivocal evidence for the validity of the Harbottle-Sutin model, since marked thermal annealing was observed even below the dehydration temperature. On the other hand, if anhydrous calcium bromate is hydrated at room temperature, only a small increase of retention is observed in spite of the phase change. The annealing capacity of the system, however, persists, for on later thermal annealing a considerable increase of retention was observed. The incompatibility of these experiments with the Harbottle-Sutin model is discussed. (auth)

6502 CHEMICAL EFFECTS FOLLOWING THE Br^{80m}–Br^{80g} ISOMERIC TRANSITION IN INORGANIC COMPLEXES. G. Schmidt (Universität, Cologne) and W. Herr. p.527-40 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

As a consequence of the isomeric transition Br^{80m}–Br^{80g} a rupture of chemical bonds is observed. The chemical effects, especially in the hexabromo complexes of Re, Os, Ir, and Pt were examined. In the solid state no appreciable separation of the isomers takes place, whereas in acid solutions the yield of the Br^{80g} may be as high as 80–90%. In Re, Os, and Ir compounds the Br^{80g}-yield is independent of environmental conditions. By contrast, the Pt-complex manifests marked, peculiar properties. The Br^{80g}-yield in $[PtBr_6]^{2-}$ proved to be dependent on the halogen-ion concentration in acid solution. In the system $[PtBr_6]^{2-} \rightleftharpoons Br^-$ a fast bromine-isotope exchange-reaction takes place which may interfere with the isomeric transition process. A careful study of this exchange reaction was found necessary. The exchange is influenced by light and by certain chemicals. Extremely good inhibitors are K_2IrCl_6, $K_3Fe(CN)_6$, etc. even in small concentrations. As the inhibitors themselves influence the Br^{80g}-yield, the experimental conditions had to be standardized in order to obtain comparable results. The chemical effects are generally regarded as a consequence of the high positive charge,

which the bromine atoms acquire as a result of the emission of conversion- and Auger-electrons. In the Pt system an "activated" halogen exchange-reaction with the excited species formed by neutralization of the positive charge must be additionally assumed. (auth)

6503 SZILARD-CHALMERS PROCESSES IN IODINE OXIDES. M. Vlatković ("Rudjer Bošković" Inst., Zagreb) and A. H. W. Aten, Jr. p.551-5 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

It is of interest to irradiate simple solid iodine compounds like iodine oxides with neutrons to elucidate the problem of the chemical state of the radioactive products. Hitherto all Szilard-Chalmers investigations concerned with radio-iodine were performed on materials containing three or more different elements. Samples of I_2O_5, I_4O_9, I_2O_4, and $I_2O_3 \cdot SO_3$ were irradiated with neutrons which had been moderated in paraffin. The irradiated material was dissolved in pure water or dilute alkali. Retention of the activity in the iodate fraction was high in the case of iodine pentoxide, where it was almost the same as has been reported for solid iodates, but even somewhat higher in I_4O_9. (auth)

6504 CONSEQUENCES OF NUCLEAR TRANSFORMATIONS IN GERMANIUM MONOCRYSTALS IRRADIATED WITH SLOW NEUTRONS. N. P. Kekelidze (Tbilisi State Univ., Georgian SSR and Lebedev Inst. of Physics, Moscow). p.557-63 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In Russian)

Irradiation of Ge crystals by slow neutrons transformed Ge^{70} and Ge^{74} into Ga and As by (n,γ) reactions. The chemical elements thus formed in the Ge act as donors and acceptors and are paramount in determining the electrophysical characteristics of the crystal. In the manufacture of semiconductor devices these impurities are specially added to Ge crystals by methods which are difficult to control. Irradiation by slow neutrons, as the best method of "introducing" impurities is of great scientific interest. With present methods it is possible to obtain Ge crystals of very high purity and perfection, which makes this material still more interesting for such research. Single crystals of Ge of "intrinsic" conductivity and a specific resistance of about 50 Ω/cm were used. The crystals were irradiated in a reactor at different neutron fluxes. Apart from the slow neutrons, a fast neutron flux 30 times smaller was employed. The integral flux of the beam was monitored by measuring the activity of cobalt acetate $[Co(CH_3COO)_2]$ placed in the reactor with the crystals. After irradiation, the samples were annealed for several hours in a vacuum of $\sim 10^{-4}$ mm Hg at 450°C to eliminate the lattice defects caused by the fast neutrons. Experiments were carried out a year after irradiation, which represents about 30 half-lives of the isotope Ge^{70}. Measurement of the temperature-dependence of the Hall emf up to helium temperatures permits the transformed elements (Ga, As) to be directly determined even in cases where their total concentration lies beyond the sensitivity limits of normal methods (chemical, spectroscopic, etc.). The results of the measurements corroborate the assumption that Ga and As are formed in Ge, and their concentrations, as determined by the method indicated, are in good agreement with those derived from calculations based on the data obtained from integrated slow-neutron fluxes, the slow-neutron capture cross-section values and the proportion of Ge^{70} and Ge^{74} in the sample. (auth)

6505 THE IRRADIATION OF THALLIUM-ORGANIC COMPOUNDS WITH NEUTRONS AND GAMMA-RAYS. D. Sarrach and G. Vormum (Joint Inst. for Nuclear Research, Dubna, USSR). p.565-9 of "Chemical Effects of Nuclear Transformations. Volume I." Vienna, International Atomic Energy Agency, 1961. (In English)

Aqueous solutions of dialkylthallium acetates were irradiated with neutrons. A large fraction of radioactive Tl^{204} was found in the chemical form of thallous acetate, whereas the remaining active atoms, as the retained fraction, appeared in the form of the parent substance. Retention is due to radiation-chemical effects and not to hot-atom processes. (auth)

Raw Materials and Feed Materials

6506 (NP-11223) ATOMIC FUEL CORPORATION ANNUAL REPORT, 1959. (Atomic Fuel Corp., Tokyo). 106p. (In Japanese)

Surface and underground prospecting methods, such as trenching, drifting, and geochemical and geophysical systems have been initiated. On the basis of trenching and drifting studies it was established that the Ningyo-toge uranium deposits stretch from the Ningyo-toge Pass eastward about 20 km through Nakatsugo and Tatsumi-toge to the Kurosawa district and northward about 15 km through Namariyama and Kaminokura to the Toge district. It is estimated that the deposit holds about 1,400,000 tons of 0.06% U_3O_8 ore. The plant using the Excer process, completed in January 1959, produced 4.2 tons of metallic U for the fabrication of the fuel elements of the JRR-3, the first reactor made in Japan. The plant operated satisfactorily using UF_4 with a density of 2.7 to 3.5 and a moisture content after dehydration of 0.1 to 0.2%, reducing it with Mg. The impurity content of the product was very low. The UF_4 hydrate contained less than 50 ppm Fe and 0.02 ppm B. A mixer-settler type extraction apparatus and a continuous bed-type ion exchange contactor have been operated satisfactorily. Basic research projects carried out at the nuclear fuel laboratory included the treatment of slime, leaching of ores from the Ningyo-toge district, development of an ion-exchange contactor, preparation of UF_4 from ore leaching solutions and heat treatment of metallic U among others. (TTT)

6507 (NP-11224) ATOMIC FUEL CORPORATION ANNUAL REPORT, 1958. (Atomic Fuel Corp., Tokyo). 118p. (In Japanese)

During the fiscal year 1958, the Atomic Fuel Corporation (Japan) laid special stress on the continued prospecting in the Ningyo-toge district which appears to be promising. The estimated U reserves at the Toge and Yotsugi areas of this district are estimated to reach several hundred thousands of tons of ore containing 0.05 to 0.06% U_3O_8. A new black mineral, called "ningyoite," found in this area contains primarily calcium-uranium phosphate. New U deposits were found in the eastern part of Nakasugo, at Tatsumi-toge, Kurami, etc. The survey of the Kurayoshi district is in progress. Construction of the buildings and installation of the equipment of a pilot plant for purification and metal processing (Excer process) were completed in January 1959. The product obtained from this plant was of high quality. A plant for milling and leaching the ores from Ningyo-toge mines is also on stream. Basic research on ore dressing, beneficiation, refining processes, metallurgical test methods, chemical, x-ray diffraction and spectroscopic analysis were carried out with special emphasis on methods for the treatment of domestic ores. (TTT)

6508 A CLASSIFICATION SCHEME FOR PRIMARY OR SECONDARY URANIUM DEPOSITS BY MEANS OF

GAMMA SPECTROMETRY. W. Recke, W. Rutherford, S. Aburto, R. Jiménez, C. Martinoya, and H. Behrens (Universidad, Concepción, Chile). Rev. soc. quim. Méx., 5: 173-5(Sept. 1961). (In Spanish)

Gamma spectrometry curves between 30 and 300 kev were given for chemically unprocessed uranium minerals. The preliminary purpose was to utilize the relation of two gamma-absorption photoelectric maxima of the sample with the corresponding relation of the same maxima of a standard of unprocessed primary uranium in order to classify the origin of uranium deposits. The energies of these maxima are 79 kev, attributed to a principal K_1 emission of the x rays of Pb–Tl–Bi of the uranium series, and 186 kev, corresponding to Ra^{226} of the same series. A serious discrepancy in the region between 90 to 98 kev is found in the various curves obtained. The great difficulty which exists in the preparation of uranium mineral standards for radiometric determinations is discussed. (tr-auth)

6509 ON THE CHEMISTRY OF REDUCTION OF URANIUM CHEMICAL CONCENTRATES. N. P. Galkin, V. A. Shubin, and A. S. Krylov. Zhur. Neorg. Khim., 6: 2325-8(Oct. 1961). (In Russian)

The reduction by hydrogen of U(VI) salts, prepared by reacting ammonium or caustic soda with uranyl sulfate (50 g/l SO_4^{2-}) at pH 7 to 8 and 80°C, is analyzed. (R.V.J.)

Separation Processes

Refer also to abstracts 7254, 7255, 7256, and 7286

6510 LIQUID-LIQUID EXTRACTION OF URANIUM (VI) WITH TRI-N-OCTYLAMINE AND DIRECT COLORIMETRIC DETERMINATION WITH MORIN. E. Cerrai and C. Testa (CISE, Segrate, Italy). Energia nucleare (Milan), 8: 737-43(Dec. 1961). (In English)

The conditions under which uranium can be quantitatively extracted with tri-n-octylamine are investigated in order to determine U directly in the organic phase. The chromogenic reaction is carried out in an ethanol medium in the presence of pyridine and morin. Uranium extractions are performed either from an 8M HCl or from a 10M NH_4NO_3 solution depending on the nature of foreign ions present in the original solution. Colorimetric determinations, made at 425 mμ, reveal high sensitivity (ε about 35,000), fairly good accuracy (±4%) and satisfactory tolerance of a large number of foreign ions. (auth)

6511 SEPARATION OF Cs^{137} AND Sr^{90} FROM OLD FISSION PRODUCTS BY ELECTROPHORESIS. I. INVESTIGATION ON ELECTROLYTES. E. Lazzarini and P. Gerontopulos (CESNEF, Milan and Istituto di Fisica del Politecnico, Milan). Energia nucleare (Milan), 8: 777-8 (Dec. 1961). (In English)

The separation of Cs^{137} and Sr^{90} from each other and from old fission products (containing Ce^{144}, Zr^{95}, Nb^{95}, Ru^{106}, and rare earths) by electrophoresis is described. An electric field of about 25 v/cm is applied to the electrophoretic paper strips, and migration times of 60 to 90 min are employed. Citrate, HCl, ammonium acetate, and acetic acid electrolytes are compared, and it is found that 0.2N acetic acid gives the most efficient separation. (T.F.H.)

6512 YTTRIUM OXIDE OF HIGH PURITY. DTPA–ION EXCHANGE PROCESS. D. R. Asher, R. D. Hansen, A. H. Seamster, Hamish Small, and R. M. Wheaton (Dow Chemical Co., Midland, Mich.). Ind. Eng. Chem., Process Design Develop., 1: No. 1, 52-6(Jan. 1962).

The commercial isolation of yttrium compounds from a mixed rare earth oxide source material is possible by an ion exchange chromatographic process using buffered diethylenetrinitrilopentaacetic acid (DTPA) as eluant. DTPA offers particular advantage over other complexing agents specifically for yttrium isolation because of the relative affinities of this chelating agent for yttrium and other rare earths. Further, the moderate water solubility of DTPA acid permits the use of acid from ion exchange resins rather than metal (copper) retaining ion and minimizes precipitation and recovery problems. Rare earth separations are improved with lower crosslinked, finer mesh cation exchange resins and at elevated temperatures. (auth)

6513 PERFORMANCE OF PULSED SIEVE-PLATE EXTRACTION COLUMNS DURING THE SEPARATION OF URANIUM FROM THORIUM. J. Behmoiras, K. J. Bril, and P. Krumholz (Research Lab. of Orquima S. A., São Paulo, Brazil). Ind. Eng. Chem., Process Design Develop., 1: No. 1, 64-8(Jan. 1962).

In the TBP–diluent-water systems, the distribution coefficients of all extractable species are severely depressed at high concentration levels of uranium in the organic phase. The highest degree of decontamination per each scrubbing stage of a discontinuous mixer-settler is obtained when nearly saturated TBP solutions in uranyl nitrate are used. However, using pulsed sieve-plate extraction columns, the optimum uranium concentration in TBP is not at the saturation level, but rather at 15% below that limit. It appears that, whereas the decontamination factor per each equivalent stage decreases, the number of equivalent stages per unit length of the column increases much more rapidly than the former with the decreasing concentration of uranium in the solvent. (auth)

6514 ANION EXCHANGE SEPARATION OF THORIUM FROM URANIUM. J. Korkisch and F. Tera (Universität, Vienna). J. Chromatog., 6: 530-4(Dec. 1961). (In English)

Work was carried out in order to develop a method for separating thorium and uranium. Equilibrium studies show that the adsorption of both tetravalent thorium and hexavalent uranium as negatively charged chloride complexes on the strongly basic anion exchanger Dowex I from solutions containing butanol and hydrochloride acid is very high, so that these two radio elements can be adsorbed on the resin simultaneously. Separation is possible due to the fact that thorium can be readily eluted with a methanol–hydrochloric acid mixture, whereas uranium is still very strongly retained on the resin under the same conditions. After the removal of thorium the uranium is eluted with 1 N hydrochloric acid. (auth)

6515 REACTOR FUEL PROCESSING. Technical Progress Review, Vol. 4, No. 4. Stephen Lawroski, ed. (Argonne National Lab., Ill.). Oct. 1961. 84p. $0.55 (GPO)(Domestic), $0.70(GPO)(Foreign).

A review of reactor fuel processing is presented. Topics covered include commercial aspects of fuel processing; research and development on aqueous processing; research and development on nonaqueous processsing; waste disposal; and production of uranium, thorium, plutonium, and their compounds. (M.C.G.)

ENGINEERING AND EQUIPMENT

General and Miscellaneous

Refer also to abstract 7269

6516 (APEX-166) HIGH TEMPERATURE CIRCULATION OF LEAD. R. J. Spera (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Sept. 7, 1954. Decl. June 16, 1961. Contract [AT(11-1)-171]. 47p.

Forced-circulation tests of high-temperature lead were conducted to develop general handling procedures and to observe the performance of typical liquid metal components in a lead environment. Inconel, Type 446 stainless steel, and Type 347 stainless steel were tested as container materials for lead at temperatures ranging from 1000 to 1500°F. No definite evidence of metal transport was observed in the stainless steel loops, but considerable amounts of metallic particles were found in the lead matrix of the Inconel loop. (auth)

6517 (IA-678) MOVEMENT OF SALTS IN SAND COLUMNS UNDER UNSATURATED CONDITIONS. R. Mokady (Israel. National and Univ. Inst. of Agriculture, Rehovoth) and E. Shalmon (Israel. Atomic Energy Commission, Rehovoth). Oct. 1961. 14p.

The movement of small amounts of 5 N NaCl in sand columns wetted by water from capillaries at varying drop rates was studied by means of electric conductivity measurements. It is proposed that in the movement of the salt down the column, the ions of the salt alternate between the mobile and immobile states. (D.L.C.)

6518 (TID-14209) A BIBLIOGRAPHY (WITH ABSTRACTS) ON GAS-LUBRICATED BEARINGS—REVISED. Interim Report. A. Peters and E. B. Sciulli—D. D. Fuller, ed. (Franklin Inst. Labs. for Research and Development, Philadelphia). Oct. 15, 1961. Contracts [AT(30-1)-1484] and Nonr-2342(00). 186p. (I-A2049-16; AD-264965).

Four hundred and sixty-four abstracts are presented on gas-lubricated bearings. All references were published prior to July 1, 1961. (N.W.R.)

6519 (UCRL-6255) NANOSECOND DATA ACQUISITION SYSTEM. Marcus R. McCraven and Richard C. Epps (California. Univ., Livermore. Lawrence Radiation Lab.). Sept. 14, 1961. Contract W-7405-eng-48. 33p.

Presented at National Telemetering Conference, Chicago, May 1961.

A system was designed for making digital measurements of transient-type analog information with timing accuracies in the nanosecond range. The measurements are then transmitted over regular telephone cable to a remote recording station. This eliminates the need for expensive, high-quality coaxial cable and the long and tedious process of manually reading film for data analysis. This system, though designed specifically to collect transient data, can be adapted to collect nanosecond data on recurrent-type functions. (D.L.C.)

6520 (WAPD-TM-259) PRESSURE, THERMAL, AND VIBRATIONAL LOADS AND DEFLECTIONS IN LINEAR ELASTIC STRUCTURES—FORTRAN II PROGRAMS CTAC AND MODE. C. M. Friedrich (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Dec. 1961. Contract AT-11-1-GEN-14. 32p.

The original CTAC-MODE program S0207, written in WOLONTIS for the IBM-650, is rewritten in FORTRAN II for the Philco 2000. The original program determined force distributions in a linear elastic structure by the following procedures: The structure is first made statistically determinate by cutting at redundant joints and applying sets of equal but opposite redundant loads on the two surfaces of each cut. The structure is separated into a set of simple elastic elements. The loads on each element are specified in terms of the external loads and redundant loads by means of a connection matrix. The deformations of each element are specified in terms of the element loads by means of a flexibility matrix. The code input consists of the external loads, connection matrices, and flexibility matrices. From this input, the program determines the working deflections, redundant loads, and modes of vibration. The effects of the loads and modes are then calculated for the elements. The new CTAC-MODE program M0041 not only performs the preceding operations, but also the following operations: determines load distributions produced by pressure and temperature, determines mode responses for a shock spectrum of acceleration factor N_g versus natural frequency f, and determines flexibility matrices for cantilever beams and cantilever subassembly plates under any plane combination of pressure, temperature, bending moment, shear force, and tensile force. (N.W.R.)

6521 SMALL SCALE HYDROGEN LIQUEFACTION. B. Yates (Bradford Inst. of Tech., [Eng.]) and F. E. Hoare. Cryogenics, 2: 84-7(Dec. 1961).

A description is given of the procedure adopted in designing a hydrogen liquefier to produce a required output. The procedure is applied to a case where 5 liters of liquid hydrogen were required to be produced without the use of a compressor. Constructional details of the purification and liquefaction systems of an accessible and easily constructed machine are included, together with performance figures. (auth)

6522 A HYDROGEN LIQUEFIER WITH AN OUTPUT OF 50 l./hr OF LIQUID HYDROGEN. A. G. Zel'dovich and Yu. K. Pilipenko (Joint Inst. for Nuclear Research, Dubna, USSR). Cryogenics, 2: 101-2(Dec. 1961).

The principal of operation and construction of a liquefier producing 50 l/hr of normal, or 30 l/hr para-hydrogen is described. The possibility is noted of the operation of the liquefier in a refrigerating cycle. A table showing the performance of the liquefier is given, and also the results of measuring the losses. (auth)

6523 DEVELOPING SUPER-LOW PRESSURES BY GAS SORPTION WITH COATED METAL FILMS. E. N. Martinson and K. N. Myznikov. Pribory i Tekh. Eksp., 6: No. 4, 71-3(July-Aug. 1961). (In Russian)

Descriptions are given of an installation and method for developing pressures of 5×10^{-10} mm mercury by coating the walls of a mercury-vapor degassed system with Ti, Zr, Ba, or Th. It is shown that oil-vapor pumps with standard glass traps can be used in developing pressures of $\sim 2 \times 20^{-9}$ mm mercury in metal containers coated with titanium. (tr-auth)

6524 A NEW EFFECTIVE SOURCE OF FAST ELECTRONS. S. P. Kapitsa. Vestnik Akad. Nauk S.S.S.R., 31: No. 10, 65-9(Oct. 1961). (In Russian)

An ordinary cyclotron with a resonant frequency in the microwave region (10 cm) has been improved by development of a new resonator to give a well-focused 7-Mev

electron beam 4 × 5 mm in size at a current of 25 milliamperes. After solving the relativistic equations of motion on a digital computer, new methods of injecting the electrons were developed by doubling the constant magnetic field of 1070 oersteds and it was possible to obtain a beam energy of 12 to 13 Mev at a current of 5 milliamperes. The use of lanthanum boride as a thermocathode in the resonator gave an emission of 100 A/cm^2 and was responsible for the successful operation of the resonator. The electron passes through the resonator 12 times in the process of acceleration. The duration of the current impulse is 2 to 2.2 microseconds. The length of the electron bunches is 5 to 7 mm. The charge density of relativistic electrons was 10^6/cm^3. The unit is compact (weight of the electromagnet is 1.5 tons), and the efficiency and current are an order of magnitude greater than the older models. Estimates show that the maximum electron energy is 50 to 100 Mev, and the maximum current is about one ampere for an accelerator of this type. Construction of a 30-Mev accelerator has been undertaken. With a beam energy of 25 to 30 Mev the unit can be used as a neutron source by bombarding heavy elements such as lead, tungsten, and uranium. The beam is well-collimated and focused with good constancy of energy. It is also an effective source of γ-rays. (TTT)

6525 THE ATTAINMENT AND MEASUREMENT OF LOW PRESSURES. Anton Klopfer (Philips-Zentrallaboratorium, Aachen). Z. angew Phys., 13: 480-91(Oct. 1961). (In German)

The present state of ultrahigh vacuum techniques permits pressures of less than 10^{-10} Torr to be obtained in small systems and up to 10^{-10} Torr in large installations. The production of the highest vacuum possible is less the question of which pump should be used, than the use of suitable technique in the construction of the vacuum system and the correct degassing method. In addition to the well-known diffusion pumps, getter-ion pumps, molecular pumps, and condensation and adsorption pumps can be used. Getter-ion pumps and especially the types that work by the principle of cathode discharge prove superior to all others because of their simple operation when the vacuum system must be maintained at low pressures for a very long time. In diffusion pumps, cold traps or oil collectors are introduced in order to prevent the penetration of propellants in the recipient and therefore perturbation in surface studies. The metal vapors must be kept off the measurement object in evaporator getter pumps. Pressure measurement instruments are known with which total or partial pressures up to about 10^{-12} Torr can be obtained. 74 references. (tr-auth)

Heat Transfer and Fluid Flow

6526 (AFOSR-1619) INVESTIGATION OF A VARIATIONAL PRINCIPLE FOR OPEN SYSTEMS. J. L. Lebowitz and E. Morris (Yeshiva Univ., New York. Graduate School of Science). [1961]. Contract AF49(638)753. 17p.

An attempt was made to obtain information about the stationary nonequilibrium state of a fluid through which heat is flowing. The fluid was considered to be in contact with several heat reservoirs at different temperatures and assumed to be described by an ensemble density μ which satisfies a generalized Liouville equation. The method used consists of minimizing a positive functional $W(\mu)$, which vanishes only when $\mu = \mu_s$, the correct stationary Γ-space distribution, by assuming a particular form for the density μ, $\mu = \hat{\mu}$, with variable parameters. The $\hat{\mu}$ chosen was essentially one representing a product of local equilibrium cononical ensembles which are varied to minimize with unsepcified space dependent macroscopic parameters. These parameters are the density $n(\underline{r})$, mean velocity $\underline{u}(\underline{r})$, and the temperature $T(\underline{r})$. The reservoirs determine the temperature on the boundaries. It is shown that $W(\hat{\mu})$ is related, somewhat indirectly, to the irreversible thermodynamic entropy production in the system and is naturally divided into parts related to the temperature and velocity gradients. Considering then a situation in which only a temperature gradient is present, $T(\underline{r})$ was varied to minimize W. This led to a differential equation for $T(\underline{r})$ subject to boundary conditions specified by the reservoirs. It is then shown that the heat conductivity deduced from this equation does not agree, in the low density limit with that computed from kinetic theory. It is further shown that this difficulty is not alleviated when the class of distribution functions used in the variational principle is modified so as to include more realistic distributions. It was therefore concluded that W is not useful as a practical variational principle. The reason for this is that W looks at too fine details of μ as is shown by the fact that it remains invariant in an isolated system. (auth)

6527 (APAE-81) RESEARCH AND DEVELOPMENT REPORTS FOR SODIUM TO SODIUM INTERMEDIATE HEAT EXCHANGER AND SODIUM TO WATER STEAM GENERATOR. (Alco Products, Inc., Schenectady, N. Y.). Oct. 30, 1960. Contract AT(11-1)-666. 134p.

Results are presented of research and development work performed in conjunction with the 70-Mw design of a sodium-to-sodium intermediate heat exchanger and a sodium-to-water steam generator. Kanigen plating was substituted for Inconel overlays. A program to evaluate this plating was undertaken. Elimination of tube end ferrules, mechanical behavior of sine wave tubes, tube-to-tube sheet welded connections, metallurgical examination of bimetallic tubes, transition weld test, bayonet tube test, and bayonet tube weld cap test are discussed. (M.C.G.)

6528 (APEX-383) SINGLE-STAGE HEAT-TRANSFER SIMULATOR. B. Kaplan and A. F. Mentink (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Aug. 22, 1955. Decl. June 16, 1961. Contracts AF33(038)-21102 and AT(11-1)-171. 61p.

The design and development of a variable-airflow, single-stage heat-transfer simulator are presented. The simulator operates on a real-time basis that enables integration into the engine-reactor control-system simulation. The simulator can be extended into a simulator for a multistage reactor. The inputs are flux, inlet air temperature, and airflow. The outputs are fuel element temperature and exit air temperature. (auth)

6529 (WAPD-AD-TH-538) ANALYSIS AND MEASUREMENT OF FLOW OSCILLATIONS. A. L. Blubaugh and E. R. Quandt (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Nov. 3, 1960. Contract AT(11-1)-Gen-14. 72p.

The results of an analytical and experimental investigation of flow instabilities are presented. The analysis started from the four basic transient equations for two-phase flow in a heated channel; energy, continuity, state, and momentum. Small perturbations were applied to each variable, and assumptions were made regarding the spatial form of the flow and enthalpy perturbations. The perturbed equations were integrated in the flow direction, and the Laplace transforms of the integrated equations taken. A constant pressure drop boundary condition was applied. The

equations were solved simultaneously for a second order transfer function which relates the flux and inlet flow perturbations. The criteria for flow instabilities may be determined from the transfer function in terms of the initial fluid conditions, channel geometry, and heat flux distribution. Two types of instability are shown to be possible; a flow excursion and a flow oscillation. Experiments were performed with water at 600 to 1600 psia to determine the fluid conditions at the inception of flow oscillations in a uniformly heated rectangular channel. These data showed that for this geometry the exit steam quality at the inception of flow oscillations is primarily a function of system pressure and channel inlet temperature. Further, these tests proved that the inception and cessation of flow oscillations is a reversible process and that it is possible to operate in an oscillatory condition without DNB. The application of the analysis by means of the HYDO code is described and a comparison of the experimental data with the results of the code calculations showed that the code, and consequently the analysis, is capable of predicting both the coolant conditions at the inception of flow oscillations and the frequency of the oscillations. To obtain optimum agreement between the measured and predicted fluid conditions at the inception of oscillations, an arbitrary form of the term expressing the density variation with enthalpy ($\partial\rho/\partial h$) in the two-phase region was selected. (auth)

6530 (WAPD-TH-400) OPTIMUM HOLE DIAMETER THROUGH THE CHANNEL WALL OF A 0.097 in. × 1 in. × 27 in. LONG TEST SECTION USED FOR TRANSIENT PRESSURE MEASUREMENT. R. Masnovi (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). July 1, 1958. Contract AT(11-1)-Gen-14. 7p.

Isothermal frictional pressure drop measurements were made on a 0.097-in. × 1-in. × 27-in. long pressure drop test section constructed with various internal diameters for the openings through the channel wall at the pressure taps. In the range of diameters at the pressure taps investigated, 0.031 to 0.0625-in. I. D., the size of the hole in the channel wall at the tap had no apparent effect on the measured pressure drop. (auth)

6531 (WAPD-TH-434) POWER PROGRAMMING FOR USE IN TRANSIENT BURNOUT AND PRESSURE DROP STUDIES. T. W. Hunt (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Sept. 8, 1958. Contract AT(11-1)-gen-14. 12p.

For use in transient burnout and pressure drop tests, a method of power programming has been developed, and tested. This power programming simulates power decays existing during typical loss of flow transients. The method utilizes a contactor field forcing system. Two generators used in the Bettis Thermal and Hydraulics Laboratory were tested under no load and load at various initial voltages. The tests were arranged to duplicate as closely as practical typical predicted power decay curves for loss of flow with and without scram. The results indicate that contactor field forcing, can simulate the predicted power decay curves within 10%. The results indicate that the instantaneous power can be measured within ±1 to 2% accuracy with existing equipment and range suppression circuitry. (auth)

6532 (CEA-tr-R-1436) ETUDE EXPERIMENTALE DE LA CONDUCTIVITE THERMIQUE DE LA VAPEUR D'EAU. (Experimental Study of the Thermal Conductivity of Steam). N. B. Vargaftik and A. A. Tarzimanov. Translated into French from Teploenergetika 7: No. 7, 12-16(July 1960). 15p.

This paper was previously abstracted from the original language and appears in NSA Vol. 15, abstract no. 2010.

6533 HEAT TRANSFER CALCULATIONS IN TUBES WITH TURBULENT FLOW OF A LIQUID HAVING A LOW PRANDTL NUMBER ($Pr \ll 1$). V. M. Borishanskii, N. I. Ivashchenko, and T. V. Zablotskaya. Atomnaya Energ., 11: 426-30(Nov. 1961). (In Russian)

In calculating heat transfer for liquid metals at low Prandtl numbers, it is assumed that the following three layers must be considered: 1) a thermal laminar layer with heat transfer by molecular conduction, 2) an intermediate thermal layer with a combination of molecular conduction and turbulent conduction, and 3) a turbulent thermal region where the heat transfer takes place only by turbulent transfer. It is assumed that there is similitude between the differences in the temperature and velocity profiles, and this assumption is verified by plotting the temperature and velocity profiles as a function of the dimensionless distance from the tube wall for water and mercury. The boundary between the thermal laminar layer and the intermediate laminar layer is given by the formula: $y_l = y_i\ (1/Pr^{\frac{1}{2}})$, where y_l is the distance of the laminary layer from the wall. Heat transfer coefficients and temperature fields were then computed by using the integral equations of R. Lyons. These calculated values based on the assumption of three layers were in better agreement with the experimental data for mercury than were the calculated values based on the assumption of two layers (a laminar layer and a turbulent layer). (TTT)

6534 CALCULATING HEAT TRANSFER ACROSS SMALL GAS-FILLED GAPS. Peter M. Lang (Allis-Chalmers Mfg. Co., Washington, D. C.). Nucleonics, 20: No. 1, 62-3(Jan. 1962).

Charts and equations are given for calculating the rate of heat transfer between surfaces at known temperatures or the temperature of one surface when the temperature of the other surface and the heat flux are specified. Results are accurate if dimensions of the surfaces are large compared to gap width and if convective heat transfer is negligible. The charts can be used to calculate the heat transfer between stacked graphite blocks in reactor cores and reflectors and between thermal shields and parts adjacent to them such as biological shields, structural materials, and reflectors. (N.W.R.)

6535 MOTION OF SPHERICAL GAS BUBBLES IN A VISCOUS LIQUID AT LARGE REYNOLDS NUMBERS. B. T. Chao (Univ. of Illinois, Urbana and Argonne National Lab., Ill.). Phys. Fluids, 5: 69-79(Jan. 1962).

An analysis is made for the motion of a gas bubble rising steadily in a quiescent liquid of infinite extent. The disturbed layer of the fluid, due to viscosity, on either side of the interface is thin when the Reynolds number is sufficiently large and thus makes possible a considerable simplification of the governing equations of motion. Simultaneous solutions of the boundary-layer equations for the flow outside and inside of the bubble are obtained considering that the tangential velocity components and the shear stresses on both sides of the interface are equal. From the calculated external stress field, the drag of a spherical bubble with negligible flow separation is evaluated. Good agreement is obtained with published data for spherical air bubbles in four different organic liquids. The experimental drag curve due to Haberman and Morton for air bubbles rising in filtered water deviates from that predicted from the present theory. The theoretical results are applicable to any fluid sphere moving steadily in a substantially immiscible, viscous liquid provided that the internal circulation is complete, the flow separation is negligible, and the Reynolds number is sufficiently large. (auth)

6536 STATIC TEMPERATURE MEASUREMENTS IN A FLOWING GAS. E. P. Muntz (Univ. of Toronto). Phys. Fluids, 5: 80-90 (Jan. 1962).

A method is developed to measure vibrational and rotational static temperatures at any point in nonradiating low-density flows of nitrogen. An electron beam is used to excite emission in the first negative system of nitrogen. The relative intensities in the rotational and vibrational structure of the emission spectra are predicted theoretically. The theoretical predictions are used to obtain rotational and vibrational temperatures of the nitrogen through which the beam passes. (auth)

Instrumentation

Refer also to abstracts 6258, 6821, 7151, 7152, 7153, 7252, and 7270

6537 (DC-58-10-44) A CONTROL SYSTEM SERVO AMPLIFIER. G. E. Gorker and R. H. Smith (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Oct. 3, 1958. Contract AT(11-1)-171. 47p.

A versatile flux regulating servo unit was designed and constructed to be mounted in a rack of nuclear instrumentation intended for operation with experimental reactors. This unit may be used to position a rod proportional to the flux error or drive a rod at a velocity proportional to the flux error. It accepts either an a-c signal from a position synchro, variable reluctance transducer, tachometer, or a d-c signal from a potentiometer depending on the feedback connections used. This unit also provides connections for on-off control of synchronous shim rod motors. A nonlinear flux derivative feedback signal was introduced to stabilize the flux servo unit for a large variety of applications. The operator may control the reactor directly from the front panel of this unit or by an extension cable to a remote control unit. (auth)

6538 (IFA-FN-21) SPARK COUNTER FOR NEUTRONOGRAPHIC RESEARCH. D. Bally and E. Tarină (Academia R. P. R. Institutul de Fizica Atomica, Bucharest). 1961. 7p.

A spark counter was built for single-crystal studies which permits the determination both the positions and intensities of neutron diffraction maxima. Laue diffraction patterns are given for a single crystal of Zn. (D.L.C.)

6539 (NDL-TR-15) RECENT DEVELOPMENTS IN THE NEUTRON ACTIVATION THRESHOLD DETECTOR SYSTEM AS USED BY THE U.S. ARMY NUCLEAR DEFENSE LABORATORY. John H. McNeilly and John W. Kinch (Army Chemical Corps Nuclear Defense Lab., Army Chemical Center, Md.). Oct. 1961. 22p.

An experimental investigation was conducted of uranium-235, magnesium, and aluminum as activation-type neutron detectors and the calibration of recently installed automatic counting equipment used with the threshold detector system. As a result of the investigation, uranium-235 (threshold of 1.5 kev), magnesium (threshold of 6.3 Mev), and aluminum (threshold of 8.1 Mev) have been added to the threshold detector system used by the Nuclear Defense Laboratory. (auth)

6540 (NP-11216) STANDARDIZATION OF RADIOISOTOPES BY 4π (α, β) AND 4π (α, β)-γ COINCIDENCE COUNTING TECHNIQUES WITH LIQUID AND PLASTIC SCINTILLATORS (thesis). Gerard Anton Brinkman (Amsterdam. Universiteit). 1961. 130p.

A survey is given of different counting techniques. Liquid and plastic scintillators are discussed. Equipment is described. The $4\pi\alpha$ and $4\pi\beta$ measurements and coincidence measurements on many isotopes are reported. Finally, γ measurements are considered. (D.L.C.)

6541 (ONR-9(Vol.I)) NAVAL RESEARCH FIFTH NAVY SCIENCE SYMPOSIUM, APRIL 18, 19, 20, 1961, U. S. NAVAL ACADEMY, ANNAPOLIS, MARYLAND. (Office of Naval Research, Washington, D. C.). 396p. (AD-260239).

Twenty-two scientific papers are included which treat a variety of topics in naval research. In addition, short papers discuss aspects of research in the respective military services. Separate abstracts were prepared for eight of the papers; one of these remaining was previously abstracted in NSA. (D.L.C.)

6542 (ONR-9(Vol.I)(p.52-63)) EVALUATION OF THE RELIABILITY OF THERMAL CONDUCTIVITY DATA ON THERMOELECTRIC MATERIALS. John W. Cadorette (Naval Engineering Experiment Station, Annapolis).

A study was made of thermal conductivity data collected on the Skinner Comparator by two different laboratories for ZrO_2, Al_2O_3, and MgO samples. It is concluded that thermal conductivity comparisons can be made with a high degree of precision and that the reproducibility of data between laboratories is adequate for development work in the thermoelectric field. (D.L.C.)

6543 (ONR-9(Vol.I)(p.104-27)) THE NRL COATING FOR NIOBIUM. R. A. Meussner (Naval Research Lab., Washington, D. C.).

Work on the alloying of Nb for oxidation protection at high temperatures is described briefly, and the research program on development of coatings for the same purpose is discussed in detail. The requirements for a successful coating is outlined, and the types of coatings considered and their deficiencies are listed. It was found that Zn forms a series of compounds with Nb which had remarkable self-repair properties and provided oxidation protection for niobium up to 1800°F. Two methods are outlined for the formation of the coatings, which were identified to be $NbZn_3$. Phase relations in the Nb–Zn system were studied and a phase diagram given. The formation of protective oxides on Nb coated with $NbZn_3$ was studied in quiet air at 1600 and 1800°F, and a mechanism is proposed which explains the oxidation and self-repair properties of the coatings. For coatings greater than 3 or 4 mils thick, the life at 1800°F is ~100 hr/mil of coating without oxidation or appreciable hardening of the Nb substrate. Coated specimens survived 3- to 5-hr tests in combustion products of H_2, C_3H_8, C_3H_8 + C_6H_6, and JP-4 fuel at 1600 to 2000°F. Final remarks are made on the requirements of coatings. (D.L.C.)

6544 (ONR-9(Vol.I)(p.143-55)) RADIATION BEHAVIOR OF ELECTRICAL MATERIALS AND COMPONENTS FOR SPACE VEHICLES. John W. Kallander and Joseph F. Weller (Naval Research Lab., Washington, D. C.).

A study was made on the effects of electron irradiation on solar cells, since solar cells must be surface-mounted on space vehicles and thus are most vulnerable to space radiation. The data are presented in the form of graphs of efficiency vs dose for various shielding thicknesses, load characteristics for various shielding darkening degrees (no irradiation), load characteristics for various doses, and efficiency vs output voltage for various doses. Preliminary irradiation results of an epoxy adhesive which may be used to cement solar cells to satellite skins are pre-

sented in the form of surface electric resistivity vs dose graph. (D.L.C.)

6545 (ONR-9(Vol.I)(p.220-33)) FREE RADICALS AND RADIATION DAMAGE IN POLYMERIC MATERIALS. R. S. Alger (Naval Radiological Defense Lab., San Francisco).

The use of electron paramagnetic resonance (EPR) techniques to study radiation damage mechanisms in organic materials is discussed. The properties of radicals (constancy, stability, photosensitivity, and scavenging) as determined by EPR are discussed, and comparative yields of stabilized radicals and disrupted molecules are given for a few organic compounds. Identification of radicals by EPR is discussed. (D.L.C.)

6546 (ONR-9(Vol.I)(p.285-302)) A NEW THERMOLUMINESCENT DOSIMETER. J. H. Schulman, F. H. Attix, E. J. West, and R. J. Ginther (Naval Research Lab., Washington, D. C.).

The design and performance of an improved thermoluminescent dosimeter using the CaF_2:Mn phosphor are described. This dosimeter has a linear response from a few mr to at least 10^4 r of Co^{60} radiation, is independent of energy between 40 kev and 1.2 Mev, and has good storage properties for health physics applications. (D.L.C.)

6547 (ONR-9(Vol.I)(p.323-7)) MEASUREMENT OF PLASMA TEMPERATURES IN THE 10,000,000°K RANGE. A. C. Kolb (Naval Research Lab., Washington, D. C.).

The operation of a magnetic mirror device and some of the results obtained are discussed. Measurement of the frequency dependence of the soft x-ray continuum with absorber foils was used to determine the electron temperature, and electron temperatures of 12×10^6°K were measured at the time of maximum magnetic field. The temperature was observed to rise at the rate of 2.5×10^6°K/μsec. (D.L.C.)

6548 (ONR-9(Vol.I)(p.328-54)) EQUATION OF STATE OF GASEOUS METALLIC PLASMAS. D. S. Villars (Naval Ordnance Test Station, Inyokern (China Lake), Calif.).

Work was done to implement H. S. Green's application of statistical mechanics to interactions between charged particles for the calculation of the equation of state of gaseous metallic plasmas. Contributions to the pressure from these interactions are given by correlation functions, which are estimated by successive iteration of an exponential. The procedure was programmed on the IBM 709 system in FORTRAN language. Results are obtainable in reasonable time for temperatures of 10^7 and 10^6°K, but the computations diverge for 10^5°K. A study was made of the convergence difficulties. (D.L.C.)

6549 (ONR-9(Vol.I)(p.355-67)) INFRARED ATOMIC SPECTRA OF FOURTH GROUP ELEMENTS. Curtis J. Humphreys and Edward Paul, Jr. (Naval Ordnance Lab., Corona, Calif.).

Extensive data are tabulated for the infrared atomic spectrum of Ge I over the range 11252 to 23921 A and correlated with predicted terms. The status of knowledge of the spectra of Sn and Pb is summarized. (D.L.C.)

6550 (TRG-Report-128) THE CHARACTERISATION OF THE PORE STRUCTURE OF GRAPHITE. B. W. Ashton and J. Winton (United Kingdom Atomic Energy Authority. Reactor Group, Culcheth, Lancs, England). Sept. 8, 1961. 15p.

The equipment being used for the determination of helium density, permeability (by gas flow), and surface area (by gas adsorption), of porous solids is described. The theory associated with these measurements is discussed. Typical values of these properties for pile Grade A graphite are tabulated. (auth)

6551 (UCRL-13025) DEVELOPMENT OF FIELD EMISSION FLASH X-RAY TUBES AND DEVICES. Final Report covering Period October 2, 1959 through August 31, 1960. (Field Emission Corp., McMinnville, Ore.). For Univ. of California Lawrence Radiation Lab., Livermore. Contract [W-7405-Eng-48], Subcontract 142. 60p.

Work was carried out on the extension of T-F emission flash x-ray tubes to high voltage (600 kv) and current (2000 amps). Good progress was made with conventional 300-kv embodiments scaled up for operation at the high voltage. The design, construction, test, and delivery of a 600-kv pulser was carried out. This pulser utilized a modified Marx-Surge circuit with lumped constant storage. Experimental studies were also carried out on Mev x-ray tubes. (M.C.G.)

6552 (WAPD-TH-435) EFFECTS OF D-C ELECTRICAL FIELDS ON THERMOCOUPLE ACCURACY. T. W. Hunt (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Aug. 15, 1958. Contract AT (11-1)-Gen-14. 12p.

Tests were performed to determine if significant thermocouple errors are produced by electrical fields similar to those existing in electrically heated thermal and hydraulic tests. The thermocouples were attached to standard 12-inch long test sections with their tips electrically insulated by a thin mica sheet. Short d-c pulses corresponding to a maximum heat flux of 2,100,000 Btu/hr-ft^2 were impressed on the test section which was in air. The current was applied for about 200 milliseconds. The fact that no variation in thermocouple reading occurred when the current was interrupted, indicated that no error from electrical fields was present. Errors as small as ±0.2°F could have been detected. Variation in electrical fields caused by circuit breaker operation produced transient excursions equivalent to 12°F at the maximum heat flux. (auth)

6553 (AEC-tr-4934) UNIVERSAL ELECTRONIC CALORIMETER. E. (Ye.) V. Kudryavtsev and K. N. Chakalev. Translated from Inzhener.-Fiz. Zhur., Akad. Nauk Belorus. S.S.R., 3: No. 1, 3-9(1960). 10p.

A universal electronic calorimeter used for determining the true values of a number of physical properties of substances as a function of temperature is described. The properties which can be determined include thermal conductivity, heat capacity, latent heat of vaporization, and electrical conductivity. (auth)

6554 (TT-984) DISCRIMINATION AMONG ELEMENTARY PARTICLES IN SCINTILLATION COUNTERS. E. Gatti. Translated by D. A. Sinclair from Rend. seminar. mat. fis. Milano, 31: 3-8(1960). 7p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 15, abstract no. 367.

6555 STEREOSCOPY IN BUBBLE CHAMBERS. CORRECTIONS FOR REFRACTION. D. Nyagu and R. G. Salukvadze (Joint Inst. for Nuclear Research, Dubna, USSR). Acad. rép. populaire Roumaine, Rev. phys., 6: 13-22(1961). (In Russian)

Image distortions in a transparent medium with a refraction coefficient n were analyzed previously. Calculations are made of corrections for the re-projected method of measuring actual geometric parameters of photographed objects. Eight graphs that can be utilized with arbitrary media with refraction coefficients $1 \leq n_0 \leq 1.28$ are included. (R.V.J.)

6556 RANGE OF PROTONS IN THE AGFA K2 NUCLEAR EMULSION. L. Medveczky and G. Somogyi (Inst. of Nuclear Research, Hungarian Academy of Sciences, Debrecen). Acta Phys. Acad. Sci. Hung., 13: 163-82(1961). (In English)

By measuring the range-energy curve of recoil protons produced in the nuclear emulsion by the reactions $H^2(d,n)He^3$ and $H^3(d,n)He^4$, calibration points were obtained to determine the range-energy relation of the Agfa K2 emulsion. The measured ranges showed good agreement within the error limits with results of calculations for Agfa K2 emulsion containing 60% relative humidity. (auth)

6557 SOME REMARKS ON THE D-C AND A-C ELECTROLUMINESCENCE OF ZnS · Cu : Mn. E. Lendvay, J. Schanda, and J. Weiszburg (Inst. of Physics and Tech., Hungarian Academy of Sciences, Budapest and Industrial Research Inst. for Telecommunication Technique, Budapest). Acta Phys. Acad. Sci. Hung., 13: 183-91(1961). (In Russian)

Analyzing the results of FAVORIN et al., it was concluded that the alterations observed in the spectrum can be explained by the local heating due to the d-c component of the a-c–d-c electroluminescence appearing simultaneously in the cells, by the thermal quenching effect found in the green light. In this case the spectra are not voltage- but heat-dependent, the temperature dependences of the bands differing from each other. (auth)

6558 STUDY OF THE EFFECT OF TEMPERATURES BETWEEN 20 AND 110°C ON THE SENSITIVITY OF IONOGRAPHIC EMULSIONS TO DIFFERENT RADIATIONS. R. Rechenmann (Centre de Recherches Nucléaires, Strasbourg). Ann. phys. (13), 6: 1001-51(July-Aug. 1961). (In French)

A systematic study was made of the behavior of Ilford C2 and G5 emulsions at 20 to 110°C, and a preliminary qualitative interpretation based on the hypothesis of the surface grain dispersion was given. A detailed description is given of the apparatus constructed for the study. (J.S.R.)

6559 THE STANDARDIZATION OF RADIOMETRIC SEPARATORS. Yu. A. Erivanskii. Atomnaya Energ., 11: 458-9(Nov. 1961). (In Russian)

In practice it is convenient to calibrate a radiometric separator by determining the setting (A) as a function of the probability of selecting a piece of ore having a known uranium content. The count rate of a definite weight of ore is given as $N_c = 0.01\ q\alpha S$, where q is the weight of the piece of ore, α is the uranium content of the piece, S is the counting efficiency in counts/gram-unit time, and N_c is the count rate in counts/unit time. The count rate of the radiometer at the setting A is given by the expression: $A = N_c + N_b + R\sqrt{N_c + N_b}$, where N_b is the background count rate, and R is probability function argument which is determined by the selection probability (at selection probabilities of 5, 50, and 95%, R is +1.65, 0.00 and −1.65 respectively). The calibration is carried out at the factory. The value of $(N_c + N_b)$ is determined at the factory on a number of standard ore samples having a known uranium content. Then the setting A is calibrated to give a known selection probability R. (TTT)

6560 THE CONFIGURATION OF THE ION BEAM FROM HIGH FREQUENCY ELECTRIC EXCITATION SOURCES AT THE LEVEL OF THE EXTRACTION CHANNEL. Daniel Blanc, André Degeilh, and Robert Saporte (C.N.R.S., Toulouse, France). Compt. rend., 253: 1682-3(Oct. 16, 1961). (In French)

A high-frequency source, with an extraction channel divided into three electrically isolated parts, was used, and the current received by each section was measured. The effects of the extraction voltage, the pressure in the ionization chamber, and the ion acceleration voltage were studied. The optimum operating conditions of the source were determined. (tr-auth)

6561 STUDY OF THE EVOLUTION OF THE LATENT IMAGE IN G-5 IONOGRAPHIC EMULSION FOR PROTONS AT THE PLATEAU. Monique Debeauvais-Wack, Henri Braun, and Pierre Cüer. Compt. rend., 253: 2517-19 (Nov. 27, 1961). (In French)

An attempt is made to eliminate the rapid regression of the image of protons near the minimum-ionization plateau, by cooling the emulsion to −196°C in order to prevent the evolution of the latent corpuscular image. By developing immediately after exposure using amidol at 24°C, a grain density of 46 grains/100μ is obtained, which is nearly twice that obtained by classical development techniques. The distribution of the gap lengths is quite regular. (T.F.H.)

6562 ON THE FORM OF THE COUNTING CHARACTERISTICS OF SPARK DETECTORS OF THE TYPE (WIRE-PLATE). Daniel Blanc and Paul Laborie (Faculté des Sciences, Toulouse, France). Compt. rend., 153: 2520-2(Nov. 27, 1961). (In French)

The slope of the characteristic may be negative when the α-particle beam is normal to the planar cathode. In practice, however, the irradiations are lateral and the slope is positive. The variation in the sensitivity of the detector (per unit length) with the current intensity of the corona effect explains the differences in the properties of detectors of different lengths. (tr-auth)

6563 A LIQUID HELIUM LEVEL INDICATOR. A. E. Rovinskii (All-Union Electrotechnical Inst., USSR). Cryogenics, 2: 115(Dec. 1961).

The circuit of the level indicator is illustrated. An automatic reduction in bridge sensitivity was provided in order to achieve a greater decrease in the reverse current on lifting the probe out of the liquid helium vessel. The tantalum sensitive resistance and the nickel ballast resistance are made in the form of 1.5 mm spirals. The liquid helium level is determined by lowering the probe slowly into the vessel. The approach of the milliameter needle to the zero division shows that 40 to 50 mm remain before the surface of the liquid. The moment at which the sensitive element is immersed in liquid is fixed very clearly. The tantalum wire heats up rapidly to above 4.3°K on raising the probe out of the liquid, and after 1 to 2 sec the instrument is ready for a repeat measurement. (P.C.H.)

6564 A 43 KGAUSS SUPERCONDUCTING SOLENOID. M. J. Fraser, J. K. Hulm, H. Riemersa, A. J. Venturino, and R. E. Wein (Westinghouse Electric Corp., Pittsburgh). Cryogenics, 2: 116-17(Dec. 1961).

Short test samples of 75% Nb–25% Zr base alloy wire were found to carry between 20 and 40 amps at 20 kgauss and 4.2°K. With the maximum permissible current in each section, a magnetic field slightly over 43000 gauss was generated in the center of the solenoid at 4.2°K. The field was monitored by a search coil and by a Hall probe at lower values. The field was found to be proportional to the current through the coil and in good agreement with the value calculated from the coil geometry. (P.C.H.)

6565 ENERGY DETECTOR FOR SATELLITES. John W. Freeman (State Univ. of Iowa, Iowa City). Electronics, 35: No. 4, 42-3(Jan. 26, 1962).

A cadmium sulfide detector, usable in satellites and capable of responding to the integrated energy flux of low-

energy electrons and protons in the Van Allen radiation zone, is described. In the detector, the bare crystal is mounted in a lead shield situated behind a series of beam-collimating and light-baffling apertures that present a circular aperture of about 12 degrees in angular diameter. Since the detectors have no physical obstruction between space and the crystal, they are sensitive to energy fluxes exceeding 1 erg/cm^2-sec-ster of electrons of energy 200 ev $\leq E \leq$ 400 kev or protons of energy 1 kev $\leq E \leq$ 10 Mev, or similar low-energy ions. The current resulting from the change in conductivity of the crystal with incident radiation is converted to pulse-code modulation for telemetering and data handling. A circuit diagram for this system is presented. (N.W.R.)

6566 A BETA-RAY ATTENUATION METHOD FOR DENSITY MEASUREMENTS OF LIQUID-GAS MIXTURES IN ADIABATIC FLOW. L. Cravarolo, A. Hassid, and S. Villani (CISE, Segrate, Italy). Energia nucleare (Milan), 8: 751-7(Dec. 1961). (In English)

Beta-ray attenuation is used to measure the density of liquid-gas mixtures flowing in vertical circular ducts in dispersed regime. For this purpose a small size source is constructed, which can be placed in different positions along the duct diameter, thus allowing density measurements in a non-uniform absorbing medium. The experimental results are in agreement with those obtained through other methods. (auth)

6567 NEW IMPROVED RESULTS OF THE LIGHT CHAMBER. G. Cavalleri (CISE, Segrate, Italy), E. Gatti, M. Nasini, and G. Redaelli. Energia nucleare (Milan), 8: 779(Dec. 1961). (In English)

Results obtained using a light chamber to detect α particles are presented. The chamber contains Ne + 2% Ar at a pressure of about 620 mm Hg. The ionized tracks in the chamber are amplified by a photomultiplier tube that is sensitive to the primary scintillation. The amplified tracks are then photographed using pretreated film. (T.F.H.)

6568 THE APERTURE ERROR OF ELECTRICAL IMMERSION LENSES IN ACCELERATOR AND DELAY CIRCUITS. R. Gobrecht (Deutsche Akademie der Wissenschaften, Berlin). Exptl. Tech. Physik, 9: 184-96 (1961). (In German)

The aperture error of immersion lenses of various models was investigated with respect to the optimum geometric lens configuration. The lenses in acceleration and delay circuits were operated under corresponding conditions. The individual lens shapes were compared under the same voltage ratio or focal distance with reference to the size of the image error. (tr-auth)

6569 ABSOLUTE MEASUREMENT OF THE NUMBER OF γ QUANTA. L. Keszthelyi, I. Berkes, I. Demeter, and I. Fodor (Central Research Inst. of Physics, Budapest). Exptl. Tech. Physik, 9: 197-203(1961). (In German)

The γ-γ coincidence method, combined with energy measurement, was applied to scintillation counters in order to determine the absolute efficiency of the counting apparatus for 4.43 and 11.67 Mev γ radiation from the $B^{11}(p,\gamma)C^{12}$ reaction. The experimental circuits used are described, and a block diagram is given. The corrections to the measured values were derived and shown graphically and tabularly. (J.S.R.)

6570 PRODUCTION OF ION PULSES IN THE NS REGION BY TRANSMISSION TIME MODULATION. R. Wagner, P. Huber, R. Plattner, and C. Poppelbaum (Universität, Basel). Helv. Phys. Acta, 34: 436-40(1961). (In German)

An attempt to take advantage of ion bunching in the simplest manner possible led to an apparatus in which the ion beam was simultaneously pushed by a HF sender and focused periodically by energy modulation. The modulation occurs with relatively small amplitude. The design and performance of the apparatus are described. (J.S.R.)

6571 AMPLITUDE-CORRECTED TIME ANALYZERS IN THE NS RANGE. R. Wagner, P. Huber, and Z. Lewandowski (Universität, Basel). Helv. Phys. Acta, 34: 440-3 (1961). (In German)

In scattering experiments with fast neutrons, the time analyzer must have a range of 0 to 200 ns at a resolution of 1 ns, a scintillator diameter of 125 mm, a 300-kev proton level in the starting channel, good linearity over the entire range, and sufficient stability. Time resolution was adversely affected by large amplitude differences of the starting signal, which leads to input pulses with too small an amplitude. To improve this, the input signals of the time-amplitude transformer were corrected by a corresponding addition. A block scheme of the corrector stage and of the time analyzer is given. The time spectra of prompt Co^{60} γ-γ coincidences, showing the effects of amplitude correction, are given. The resolution of this analyzer is graphed for side channel levels. (J.S.R.)

6572 METHOD FOR ANALYSIS OF AN ION BEAM. A. Heym, C. Joseph, and J. F. Loude (Ecole Polytechnique de l'Université, Lausanne, Switzerland). Helv. Phys. Acta, 34: 444-6(1961). (In French)

An apparatus, based on the time of flight of ions in a variable electric field, was designed to study ion beam composition as a function of the control parameters of the source (gas pressure, HF power, and extraction potential). The experimental apparatus was sketched. Experimental results show that the ion composition of the beam depends on the gas pressure in the source, with high pressure favoring the production of monoatomic ions. A weak HF excitation, at the extinction limit of the source, favors the production of triatomic ions. (J.S.R.)

6573 AN ATOMIC BEAM AS TARGET FOR NUCLEAR SCATTERING. H. H. Mueller, H. H. Staub, and H. Winkler (Universität, Zurich). Helv. Phys. Acta, 34: 446-9(1961). (In German)

In the determination of level widths, the Doppler effect causes an energy broadening. The broadening can be suppressed without the application of low temperatures when an atomic beam is used as a target. The design of an apparatus for measuring scattering occurring with atomic beam targets is given, and the factors affecting its performance are discussed. The intensity distribution of H_2 as a function of the angle from the beam axis was measured to show the performance of the device. (J.S.R.)

6574 180° DEFLECTION MAGNET FOR THE ABSOLUTE DETERMINATION OF PARTICLE ENERGIES. H. Winkler and W. Zych (Universität, Zurich). Helv. Phys. Acta, 34: 449-54(1961). (In German)

A magnet used for the absolute determination of particle energies by deflection through 180° in a homogeneous magnetic field is described in detail. The magnet has good time constancy and homogeneity along the particle orbit of more than 150 cm. A cross section of the magnet is given, and the circuit used for the time stabilization of the field is shown. (J.S.R.)

6575 A CUVETTE EXCHANGER FOR MEASUREMENT OF C^{14} AND S^{35} WITH LIQUID SCINTILLATORS. R. Reichel (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Isotopentechnik, 1: 221-3(Sept. 1961). (In German)

From the factors which affect the size of the thermal zero effect of photoelectron multipliers, the advantages which an arrangement permitting the exchange of curvettes for the liquid scintillator in the absence of light offers are derived. Such an apparatus is described. (tr-auth)

6576 SCINTILLATION METHOD IN LIQUID MEDIUM APPLIED TO THE QUANTITATIVE MEASUREMENT OF TRITIUM FIXED IN BACTERIA. Sonia Apelgot and Maurice Duquesne (Institut du Radium, Paris). J. chim. phys., 58: 774-7(Sept. 1961). (In French)

In order to determine the quantity of H^3 fixed in bacteria placed in tritiated medium, the liquid scintillation technique was used. On a given support, an aliquot portion of the growth medium or of the bacteria suspension was placed. The experiment shows that if the support is a paper filter, the yield of the measurement depends strongly on the intra- or extrabacteria localization of the tritium. On the other hand, if the support is an electrophoresis membrane, the measurement yield is independent and high. (tr-auth)

6577 THE DISCHARGE CHAMBER AND ITS CHARACTERISTICS. Shūji Fukui (Nagoya Univ., Japan) and Sigenori Miyamoto. J. Phys. Soc. Japan, 16: 2574-85 (Dec. 1961). (In English)

The discharge chamber is one of the particle detectors based on gaseous discharge. The chamber can give a visual indication of the particle tracks. It consists of glass boxes filled with a neon and argon gas mixture at atmospheric pressure. The operating conditions and other characteristics are presented and discussed. (auth)

6578 A MECHANICAL FILTER FOR BEAM EXPERIMENTS WITH THERMAL NEUTRONS AT THE REACTOR. K. F. Alexander and R. Kaestner (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Kernenergie, 4: 707(Sept. 1961). (In German)

In beam experiments with thermal neutrons the fast neutrons in the beam and the accompanying γ radiation are frequently unwanted. For suppression of these radiation components with the smallest possible attenuation of the thermal part, a mechanical filter was developed. The apparatus works on the principle of a mechanical monochromator in which a wider range of the Maxwell spectrum is passed through with higher transmission. The design and performance of the filter are briefly reported. (J.S.R.)

6579 BETA SCINTILLATION COUNTING WITH THIN PLASTIC PHOSPHORS. John H. Harley, Naomi A. Hallden, and Isabel M. Fisenne (New York Operations Office, AEC). Nucleonics, 20: No. 1, 59-61(Jan. 1962).

The design and performance characteristics of a simple, efficient low-background beta scintillation counter without anticoincidence are described. The counter with thin plastic phosphors is dense enough to see beta particles and yet thin enough to reduce background to 0.5 cpm. The system can be easily converted into an alpha counter if one simply substitutes a zinc-sulfide phosphor for the plastic one and reduces the gain. (N.W.R.)

6580 MASS SEPARATOR FOR THE MASS SEPARATION OF FISSION PRODUCTS. Peter Armbruster (AEG-Entwicklungsleitung and Technische Hochschule, Munich). Nukleonik, 3: 188-94(Oct. 1961). (In German)

For the investigation of the complicated processes in nuclear fission and in the passage of fission products through matter, a distribution of the fission products according to their masses is desirable. A separation is possible with a correspondingly large mass spectrometer, but very expensive. A relatively simple method, in which the fission products are deflected through a magnetic field filled with gas, was applied first by Fulmer and Cohen. This method was studied further at the Munich Research Reactor and is described in the present article. For the mass separation of the fission products a stigmatically focused magnetic deflection system was used. The utilization of charge reversal phenomena of heavy ions in the residual gas permits a mass analysis of the fission products. Measurements on the $H\rho$ distribution of the fission products are discussed in dependence on the filling gas pressure. From the measurements conclusions are drawn on the velocity dependence of the ion charge of the fission products. (tr-auth)

6581 THE LINEAR CIRCUIT FOR MEASURING THE AMPLITUDE RATIO OF TWO PULSES. Ryszard Bayer (Inst. of Nuclear Research, Polish Academy of Science, Warsaw). Nukleonika, 6: 749-56(1961). (In English)

A circuit that changes linearly the amplitude ratio of two pulses coming simultaneously into time is described. Its working principle is based on the use of Miller effect in a pentode tube. Considering some steady parameters, it is found that the sweep time is inversely proportional to the first grid voltage. Thus, if the amplitude of the second pulse is applied to the first grid, a linear dependence of the pulse width appearing at the second grid on the ratio of pulses is obtained. Performance and parameters of such a circuit are described. (auth)

6582 OPERATION OF ARDENNE DUO-PLASMOTRON. S. N. Popov (Inst. of Chemical Physics, Academy of Sciences, USSR). Pribory i Tekh. Ekspt., 6: No. 4, 20-4(July-Aug. 1961). (In Russian)

Von Ardenne duo-plasmotron hydrogen ion output reached 30μ. The current density in the emission channel is 3 a/cm^3. The ion current yield as a function of distance between anodes was determined, and the effects of the main anode shape on ion current yield were found. (tr-auth)

6583 MEASUREMENTS OF ENERGY FLUX IN HIGH ENERGY PHOTON BEAMS BY THE AREA UNDER CASCADE CURVE. I. N. Usova (Inst. of Physics, Academy of Sciences, USSR). Pribory i Tekh. Ekspt., 6: No. 4, 27-30 (July-Aug. 1961). (In Russian)

Absolute γ intensity measurements were made using area-under-cascade curves in lead. The ratio of the delaying properties of gas and matter was determined with a higher order of accuracy by using heavy matter. Absorption of soft electrons by the chamber wall was eliminated by a specially designed chamber. Absolute magnitudes of the energy flux were determined and the obtained results are in agreement with measurements made with thick-walled graphite chambers. (tr-auth)

6584 SPECTROMETER FOR FAST NEUTRONS. G. P. Antropov, Yu. A. Zysin, A. A. Kovrizhnykh, and V. P. Tsarev. Pribory i Tekh. Ekspt., 6: No. 4, 30-3 (July-Aug. 1961). (In Russian)

Descriptions are given of a neutron spectrometer based on the principle of combined amplitudes of two proportional counters recording α particles and tritium nuclei produced in $Li^6(n,\alpha)T$ reactions in a thin Li^6 layer placed between the counter filaments. The spectrometer is highly efficient and is capable of producing spectra of sources with intensities of $\sim 10^5$ n/sec; no collimated neutron flux is required. The operating range is 1 to 10 Mev. (tr-auth)

6585 MULTICHANNEL DEVICE FOR MEASURING β-γ AND β-e-ANGULAR CORRELATION. A. V. Borovikov, V. S. Gvozdev, G. D. Porsev (Inst. of Physics and Tech., Academy of Sciences, USSR). Pribory i Tekh. Ekspt., 6: No. 4, 33-4(July-Aug. 1961). (In Russian)

A method is suggested for measuring β-e angular correlation without changing the angle between magnetic spectrometer axes. Descriptions are given of a multichannel installation with 10^{-3} coincidences per cascade and 1.5% resolution that is used with the suggested method. (R.V.J.)

6586 PARAMETERS FOR PULSE GAS DISCHARGE COUNTERS. V. P. Ivanov and V. V. Sidorenko. Pribory i Tekh. Ekspt., 6: No. 4, 35-8(July-Aug. 1961). (In Russian)

Performance of pulse type gas-discharge counters is analyzed, and formulas are developed for selecting the most efficient counter parameters. It is shown that automatic regulation of pulse feeding frequencies produced linear load characteristics for a wide range. (R.V.J.)

6587 DETERMINATION OF ABSOLUTE ACTIVITY BY END-WINDOW COUNTER. I. A. Vasil'ev, K. A. Petrzhak, and V. D. Sushchkovskii (Leningrad Technological Inst.). Pribory i Tekh. Ekspt., 6: No. 4, 39-42(July-Aug. 1961). (In Russian)

The dependence of end-window counter absolute efficiency on the mean β spectrum energy was determined using a series of long-life isotopes. The obtained data are utilized for finding the absolute activity of other isotopes (the relative order of error is 8 to 14%). Conversion electrons with energies considerably smaller than the β energy are absorbed by a filter-absorber. An isotope can then be considered as pure β emitter. (tr-auth)

6588 OBSERVATIONS OF NUCLEAR MAGNETIC RESONANCE IN UNSTABLE FIELDS. K. V. Vladimirskii and B. A. Labzov (Inst. of Physics, Academy of Sciences, USSR). Pribory i Tekh. Ekspt., 6: No. 4, 59-61(July-Aug. 1961). (In Russian)

Distortions of nuclear magnetic resonance caused by magnetic field time instability are investigated. It is shown that counters with high time constants are able to develop undistorted spectra when the field instability exceeds the band width. (tr-auth)

6589 ANALYSIS OF ROSSI TYPE COINCIDENCE SCHEMES. A. A. Sanin and N. N. Dmitrieva (Moscow State Univ.). Pribory i Tekh. Ekspt., 6: No. 4, 61-4(July-Aug. 1961). (In Russian)

In two-channel Rossi type coincidence schemes the selection factor is 5 to 6 times higher for a resolving time $\tau_p > 3\tau$, where τ is the time constant of the commutation element. (tr-auth)

6590 SINGLE-CHANNEL DIFFERENTIAL COINCIDENCE CIRCUIT DISCRIMINATOR FOR SCINTILLATION COUNTERS. V. O. Vyazemskii, A. N. Pisarevskii, and Yu. E. Selyaninov (Radium Inst., Academy of Sciences, USSR). Pribory i Tekh. Ekspt., 6: No. 4, 64-6(July-Aug. 1961). (In Russian)

A single channel differential discriminator in which a saturated amplifier combines the time coupling to the investigated pulse starting point is described. The discriminator is designed to operate with fast coincidence schemes using slow scintillators. (tr-auth)

6591 DESIGN OF SHUNTS FOR RECORDING NANOSECOND PULSE CURRENT. S. I. Andreev (State Optical Inst., [USSR]). Pribory i Tekh. Ekspt., 6: No. 4, 87-9(July-Aug. 1961). (In Russian)

A shunt with a time constant not exceeding 10^{-10} sec is described. The shunt is able to record, without distortions, currents of several ka with rise times of several nanosec. No induction compensation is required. A direct bypass control using a recording signal is described. (tr-auth)

6592 MEASUREMENTS OF ELECTRIC PROPERTIES OF NEUTRON IRRADIATED DIELECTRICS. L. K. Vodop'yanov (Inst. of Physics, Academy of Sciences, USSR). Pribory i Tekh. Ekspt., 6: No. 4, 116-18(July-Aug. 1961). (In Russian)

Descriptions are given of a device for measuring, in a high vacuum and under a wide range of temperatures and frequencies, the dielectric penetrability, dielectric loss, and electric conductivity of highly radioactive dielectric specimens. The device is equipped with a shield for protecting personnel. (R.V.J.)

6593 PRESSED PLASTIC SCINTILLATORS WITH ORGANIC ADMIXTURES. E. A. Adreeshchev, E. E. Baroni, N. S. Kursanova, and I. M. Rozman. Pribory i Tekh. Ekspt., 6: No. 4, 151(July-Aug. 1961). (In Russian)

Plastic scintillators were prepared from styrene with 3% n-terphenyl and 0.04% 1, 3, 5 triphenyl-Δ^2-pyrozolyne by pressing for three hours at 125 to 130°C at 2.5 kg/cm^2 (without using inert gas). $Pb(C_6H_5)_4$, $Hg(C_6H_5)_2$, $Sn(C_6H_5)_4$, and $As(C_6H_5)_3$ were used as activators. The relative yield of pressed scintillators is tabulated. (R.V.J.)

6594 CELLS FOR NUCLEAR SCINTILLATION COUNTERS. V. V. Artem'ev (Inst. of Archeology, Leningrad). Pribory i Tekh. Ekspt., 6: No. 4, 152(July-Aug. 1961). (In Russian)

The performance of a plastic scintillation detector was tested with C^{14} in direct contact between the liquid scintillator and the photocathode window. The results show the detector has better light absorption power and lower background than quartz or glass detectors. (R.V.J.)

6595 FAST ACTING VACUUM SLUICE IN MASS SPECTROMETER. V. I. Karotaev (Inst. of Physics and Tech., Academy of Sciences, USSR). Pribory i Tekh. Ekspt., 6: No. 4, 162-3(July-Aug. 1961). (In Russian)

A fast-acting mass spectrometer sluice design with a dome valve is given. The sluicing operations last 1 to 2 min and pumping 10 to 15 min. The source chamber volume is 200 cm^3, the sluice volume ~75 cm^3, and the dome valve volume ~5 cm^3. During pumping the area under the dome acts as an intermediate chamber. (R.V.J.)

6596 ON APPLICATION OF Ne^{21} IN FAST NEUTRON SPECTROMETRY. A. I. Abramov. Pribory i Tekh. Ekspt., 6: No. 5, 30-3(Sept.-Oct. 1961). (In Russian)

The performance of spectrometric ionization chambers filled with Ne^{21} instead of He^3 is described. It is shown that the $Ne^{21}(n,\alpha)O^{18}$ reaction is effective in fast neutron spectrometry. (R.V.J.)

6597 COLLIMATION OF NEUTRONS FOR T(d,n) He^4 REACTION, BY SELECTING $\alpha-n$ COINCIDENCES. Yu. V. Dukarevich and A. N. Dyumin (Inst. of Physics and Tech., Academy of Sciences, USSR). Pribory i Tekh. Ekspt., 6: No. 5, 34-6(Sept.-Oct. 1961). (In Russian)

The production of narrow collimated neutron beams used for measuring differential cross sections of elastic scattering at 14.2 Mev is described. A device for separating γ and neutron signals was installed in the neutron detector. The angular resolution is ±45'. The detector with a 20-cm-thick steel collimator is capable of measurements starting at ~2.5° angles. (tr-auth)

6598 MEASUREMENTS OF TRITON SPECTRA IN NUCLEAR REACTIONS. A. A. Ogloblin and V. I. Chuev. Pribory i Tekh. Ekspt., 6: No. 5, 37-41(Sept.-Oct. 1961). (In Russian)

Measurements of energy and angular distributions of tritons from nuclear reactions are described. Tritons emitting from thin targets are captured by a stack of foils arranged around the target, and the induced activity of each foil is measured. The absence of other charged par-

ticles in the background allows unhampered measurements in a wide range of energies. (R.V.J.)

6599 MAGNETIC SPECTROMETER FOR INVESTIGATING WEAK POSITRON SPECTRA. S. S. Vasilenko, M. G. Kaganskii, and D. L. Kaminskii (Inst. of Physics and Tech., Academy of Sciences, USSR). Pribory i Tekh. Eksp., 6: No. 5, 42-4(Sept.-Oct. 1961). (In Russian)

Descriptions are given of a spectrometer with initial focusing in a transverse heterogeneous sector-type magnetic field then in a longitudinal field. Data obtained on positron spectra from Ag^{110m} decay indicate the usefulness of the device in studies of spectra with 10^{-8} to 10^{-9} positrons per decay. (tr-auth)

6600 SEMI-AUTOMATIC DEVICE FOR MEASURING MULTIPLE SCATTERING. A. O. Vaisenberg and V. A. Smirnitskii. Pribory i Tekh. Eksp., 6: No. 5, 44-7(Sept.-Oct. 1961). (In Russian)

Photoelectric and induction transducers were designed for semiautomatic installations for measuring multiple scattering and for automatic microscope tables. A block diagram and photographs are included. (tr-auth)

6601 LOW-PRESSURE PROPORTIONAL DETECTORS. A. B. Kurepin and V. L. Maduev (Inst. of Physics, Academy of Sciences, USSR). Pribory i Tekh. Eksp., 6: No. 5, 48-50(Sept.-Oct. 1961). (In Russian)

An analysis is made of the performance of a low-pressure (2 to 10 mm mercury) proportional counter filled with deuterium and capable of recording low-energy (up to 10 kev) p, d, He^3, and T in a background of high-energy particles and secondary electrons. The gas amplification coefficient is plotted as a function of the counter parameters. The selection of an optimum filament thickness is discussed. (tr-auth)

6602 ELECTRON ADHESION EFFECTS IN IONIZATION CHAMBER. E. A. Damaskinskii, G. A. Korolev, and G. E. Kocharov (Inst. of Physics and Tech., Academy of Sciences, USSR). Pribory i Tekh. Eksp., 6: No. 5, 51-4 (Sept.-Oct. 1961). (In Russian)

The problem of electron adhesion to electro-negative admixtures during the operation of an ionization chamber with a grid is discussed. It is shown that the addition of gas mixtures reduces electron adhesion to a minimum. A formula was derived for determining the number of electrons lost in the adhesion. (tr-auth)

6603 ELECTRON MULTIPLIER FOR RECORDING PASSING CHARGED PARTICLES. A. I. Akishin (Moscow State Univ.). Pribory i Tekh. Eksp., 6: No. 5, 54-6(Sept.-Oct. 1961). (In Russian)

The construction and characteristics are given for an electron multiplier designed for recording low-energy charged particles. (tr-auth)

6604 CONSIDERATION OF SELF-ABSORPTION AND SELF-SCATTERING IN ABSOLUTE ACTIVITY MEASUREMENTS IN THICK-LAYER PREPARATIONS. S. V. Belov, V. M. Epokhin, L. M. Anokhina, and Yu. V. Solov'ev. Pribory i Tekh. Eksp., 6: No. 5, 56-62(Sept.-Oct. 1961). (In Russian)

Published data on the determination of $\mu = f(E_{max})$ are generalized. The function is expressed as $\mu = 0.01523E_{max}^{-1.514}$ A correction nomogram was prepared for β absorption. β self-absorption curves were developed at 4 π-solid angle for Y^{90} and Y^{91}. Calibration curves were found for determining self-absorption and scattering corrections to Sr^{89}, Sr^{90}, Y^{90}, Y^{91}, Ce^{141}, and $Ce^{144} \rightarrow Pr^{144}$ activity measurements made with an end-window counter. (tr-auth)

6605 RELAY-DETECTOR FOR GAMMA EMISSION. M. Birnbaum, V. Popesku, and T. Taitel (Inst. of Nuclear Physics, Bucharest). Pribory i Tekh. Eksp., 6: No. 5, 62-4(Sept.-Oct. 1961). (In Russian)

Descriptions are given of a γ-detector scheme with a single semi-conductor triode operating in relay. A halogen counter acts as a transducer. The threshold of relay response is 10^5 to 3×10^2 imp/sec; the time constant is 0.1 to 15 sec. The construction is adapted to industrial requirements. (tr-auth)

6606 MULTICHANNEL FAST COINCIDENCE CIRCUIT. M. Vysochanskii, S. V. Mukhin, Ts'ung-ch'ing Ping, S. V. Rikhvitskii, and I. N. Semenyushkin (Joint Inst. for Nuclear Research, Dubna, USSR). Pribory i Tekh. Eksp., 6: No. 5, 67-71(Sept.-Oct. 1961). (In Russian)

A diode coincidence circuit with fast separation, operating at 100% efficiency with a tri-channel coincidence scintillation counter, performs with a resolving time of 1.8 sec and a separation time at 0.1% N_{max} of 3.2 nanosec. The dead time is 300 nanosec. The circuit operates with negative pulse amplitudes of $\gtrsim$500 mv. (tr-auth)

6607 REGULATOR FOR NANOSECOND PULSE APPARATUS. O. S. Kolotov, A. A. Sanin, and Z. Shil'berskii (Moscow State Univ.). Pribory i Tekh. Eksp., 6: No. 5, 82-6(Sept.-Oct. 1961). (In Russian)

The design is given of a universal apparatus for studying 2×10^{-9} to 2×10^{-7} sec transition processes. The apparatus consists of an oscillograph with a maximum scanning rate of 10^9 cm/sec, two pulse generators with a front rise time of 2 nanosec, and an amplifier with an amplification coefficient of ~50. The time between the generator starting points can be smoothly changed from 0 to 150 nanosec. (tr-auth)

6608 NUCLEAR MAGNETIC RESONANCE SPECTROMETER OF HIGH RESOLVING POWER. Yu. Yu. Samitov (Kazan State Univ.). Pribory i Tekh. Eksp., 6: No. 5, 100-8(Sept.-Oct. 1961). (In Russian)

A spectrometer was developed for investigating the structure of organic compounds. The relative resolving power without specimen rotation is 10^{-7} and with rotation 5×10^{-8}. The spectrometer is designed with a 5720 gauss constant magnetic field and a nuclear-induction flux supplied by a highly-stable quartz generator. The spectrum is taken directly on an oscillograph screen with an automatic recorder. (tr-auth)

6609 SPECTRUM FREQUENCY ANALYZER FOR STUDYING CYCLOTRON HYDROGEN IONS. A. N. Karkhov. Pribory i Tekh. Eksp., 6: No. 5, 115-18(Sept.-Oct. 1961). (In Russian)

A spectrum analyzer with a frequency range of 1 to 18 Mc was designed for studying the harmonic composition of H_2^+ and H^+ emission in plasma. The analyzer permits the observation of any part of the spectrum at any frequency. The sensitivity of the analyzer is 3 to 4 μv, the pass band is 0.13 Mc, and the frequency of scanning is 200 c. The frequency and amplitude are measured by correlating spectrum components with standard signals from a generator. (tr-auth)

6610 DESIGN OF 4 π COUNTER FOR MEASURING WEAK ACTIVITIES. K. A. Petrzhak and R. V. Sedletskii (Leningrad Inst. of Tech.). Pribory i Tekh. Eksp., 6: No. 5, 177-8(Sept.-Oct. 1961). (In Russian)

A 4 π counter was designed with a means for facilitating sample change and improved isolation from the atmosphere. The counter has an integral background of 2 to 3 imp/min and can be utilized for measuring very weak activities. (R.V.J.)

6611 ION RECEIVER ADAPTED TO MASS SPECTROMETER FOR N AND O ISOTOPIC ANALYSIS. V. E. Vetshtein and S. G. Demidenko (Inst. of Physical Chemistry, Academy of Sciences, Ukrainian SSR). Pribory i Tekh. Ekspt., 6: No. 5, 185-6(Sept.-Oct. 1961). (In Russian)

A three-slit ion receiver is adapted to a two-beam mass spectrometer, allowing the determination of isotopic masses 28 : 29, 32 : 34, and 44 : 46. The order of accuracy is ±0.5%. (tr-auth)

6612 DEVICE FOR MEASURING THE AZIMUTHAL AND RADIAL MAGNETIC FIELD INTENSITY. D. P. Vasilevskaya and Yu. N. Denisov (Joint Inst. for Nuclear Research, Dubna, USSR). Pribory i Tekh. Ekspt., 6: No. 5, 194-5(Sept.-Oct. 1961). (In Russian)

A device for measuring radial and azimuthal components of constant magnetic fields, based on the Hall effect, is described. A germanium n-type crystal, 5 × 3 × 0.2 mm, is used as transducer. The response of the device, 0.2 gauss, does not depend on the field z-component intensity. (tr-auth)

6613 ENERGY DETERMINATION OF FAST ELECTRONS FROM DEEP DOSE CURVES. Benno Markus (Universitäts-Hautklinik, Gottingen, Ger.). Strahlentherapie, 116: 280-6(Oct. 1961). (In German)

The reliability of the practical (extrapolated) range of fast electrons for the determination of the energy of electrons with homogeneous energy and in a parallel beam is shown. A modification of a previously published linear equation, which expresses the relationship between kinetic energy and the practical range of fast electrons in water and some other phantom substances composed of light elements, is proved by means of all depth dose curves, presented in the literature between 1.5 and 40 Mev as well as by means of absolute measurements of electron energies between 3 and 15 Mev. Additional measurements of the depth dose, using water, the tissue equivalent phantom substance M3, and plexiglass were done. As a result, the practical range can be represented by both of those equations with good or excellent accuracy. Otherwise, there is given the possibility of determining very accurately the electron energy from a depth dose curve without any great expense. (auth)

6614 INVESTIGATIONS ON THE ANGLE DEPENDENCE OF IONIZATION CHAMBERS. Felix Wachsmann and Iwao Azuma (Universität, Erlangen, Ger.). Strahlentherapie, 116: 287-96(Oct. 1961). (In German)

Various types of commerical ionization chambers, which are commonly used in Germany, were studied for the angle dependency of their readings. The graphically represented results show that the thimble chambers are sensitive to an influence of their handles. The angle dependency is sometimes very great for other chamber types (pot and phantom chamber), however, it is almost negligible if the chamber is adjusted properly. The errors for the incidental radiation which comes diffusely from all angles of space are calculated; they remain within acceptable limitations. (auth)

6615 THE PROPORTIONAL COUNTERS IN X-RAY SPECTROMETRY. G. Seibel (IRSID, Saint-Germain-en-Laye, France). Vide, 16: 189-204(July-Aug. 1961). (In French)

The characteristics of detectors used for x-ray spectrometry are first briefly reviewed. The operational principles of proportional counters for this purpose are then described, and their construction is discussed. Proportional counters now being used for x-ray spectrometry are reviewed, and the range of application is given. (J.S.R.)

Materials Testing

6616 (APEX-143) RED HEAT METHOD FOR DETECTING METALLURGICAL BONDING DEFECTS IN STAINLESS STEEL CLAD FUEL SHEETS. SUMMARY REPORT ON BOND TESTING. Don L. Moore (General Electric Co. Aircraft Nuclear Propulsion Dept.,[Cincinnati]). Oct. 5, 1953. Decl. July 6, 1961. 42p. Contract [AT(11-1)-171].

A test was developed to determine the integrity of the metallurgical bond between the core and the cladding of sheet type fuel elements. The test is basically one of thermal conductivity and is thus a direct approach to the hypothesis that hot spots would develop from areas of poor bonding due to the reduction in heat dissipation from the core to the surface of the sheet. In this test the surface of the sheet achieves a uniform temperature, and therefore a uniform color at high temperature except at areas of poor bonding. A defect area will exhibit a shadow-like appearance and may be observed with the eye. Experimental results showed this method to be sufficiently accurate to detect defects of diameters $^1/_{16}$ in. or greater. The method is adaptable to production and may be performed by a single laboratory technician; it was therefore adopted in preference to the electrode potential, ultrasonic, frost, thermographic, and phosphor methods also described. (auth)

6617 PROCEEDINGS OF THE THIRD INTERNATIONAL CONFERENCE ON NONDESTRUCTIVE TESTING, TOKYO & OSAKA, MARCH, 1960. Tokyo, Pan-Pacific Press, 1961. 803p.

Ninety-eight papers are included; separate abstracts have been prepared for seven. One paper was previously abstracted in NSA. The papers are grouped in the following divisions: general; radiography; ultrasonic testing; electric, magnetic particle, and penetrant testing; and x-ray stress measurement. The main fields of interest are: calibration and standard test methods of various types of apparatus and materials for nondestructive testing, testing of materials in relation to their quality, testing in shipbuilding as applied to structure and power equipment, and relation between results of nondestructive testing of materials and their mechanical strength. (N.W.R.)

6618 NONDESTRUCTIVE TESTING AND SURFACE TREATMENT OF TUBULAR COMPONENTS FOR NUCLEAR APPLICATIONS AT HANFORD. Richard B. Socky (General Electric Co., Richland, Wash.). p.405-13 of "Proceedings of the Third International Conference on Nondestructive Testing, Tokyo & Osaka, March, 1960." Tokyo, Pan-Pacific Press, 1961. (In English)

Nondestructive testing methods and a tube testing facility are described. The unique feature of the testing facility is the ability to handle tubes of lengths up to 60 feet. The tests and treatment methods described along with the associated facilities include: fluorescent penetrant testing with examination of both outside and inside surfaces, eddy current testing using OD and ID probes, immersed ultrasonic testing for internal discontinuities, radiographic examination of suspect areas, white light borescope examination, ultrasonic wall thickness measurement, air gage and linear transformer outside and inside diameter measurements, surface treatment by vapor blasting and acid pickling, and autoclave treatment for corrosion susceptibility and oxide film generation. (N.W.R.)

6619 NONDESTRUCTIVE TESTING OF REACTOR FUEL ELEMENTS AT HANFORD. Ronald S. Paul (General Electric Co., Richland, Wash.). p.423-8 of "Proceed-

ings of the Third International Conference on Nondestructive Testing, Tokyo & Osaka, March, 1960." Tokyo, Pan-Pacific Press, 1961. (In English)

The dimensional stability of cylindrical natural uranium fuel cores during neutron irradiation is dependent upon the uranium grain size, grain orientation, and absence of internal defects. Ultrasonic attenuation methods are used routinely to test for proper grain size. A nondestructive sonic resonance vibration test for grain orientation is under investigation. Both ultrasonic and eddy current tests are used to detect certain types of internal defects. After the fuel core is clad in a jacket of aluminum or zirconium, highly sensitive and rapid ultrasonic methods are used to test the quality of the bond between the jacket and core and to reject fuel elements which would likely exhibit poor heat transfer characteristics. Adequate clad thickness to protect the core from coolant corrosion is assured by an eddy current test based on differences in electrical conductivities between the clad and core materials. Eddy current tests are also used to inspect the clad for small cracks or pinhole-type defects. Most fuel elements have an end closure weld which is inspected by radiography and in some cases by an ultrasonic test. Some nondestructive tests are automated for testing production quantities of fuel elements. Methods are also described for obtaining quantitative data from testers in digital form for convenient analysis by data processing machines. Research being done at Hanford on nondestructive testing is also described. (N.W.R.)

6620 NEW TECHNIQUES FOR TESTING NUCLEAR REACTOR COMPONENTS. W. J. McGonnagle (Argonne National Lab., Ill.). p.432-41 of "Proceedings of the Third International Conference on Nondestructive Testing, Tokyo & Osaka, March, 1960." Tokyo, Pan-Pacific Press, 1961. (In English)

Nondestructive testing methods and techniques developed and used at Argonne National Laboratory are reviewed. The methods and techniques used for reactor component testing are: ultrasonic, eddy current, x rays, gamma rays, and beta rays. (N.W.R.)

6621 FACILITIES FOR NONDESTRUCTIVE TESTING AT THE LAWRENCE RADIATION LABORATORY. Robert B. Oliver (Univ. of California, Livermore). p.441-6 of "Proceedings of the Third International Conference on Nondestructive testing, Tokyo & Osaka, March, 1960." Tokyo, Pan-Pacific Press, 1961. (In English)

Details of the physical arrangement of the nondestructive testing facilities of Lawrence Radiation Laboratory are presented. The facilities are an outstanding example of the equipment required to support most effectively the work of a nuclear research laboratory. The principal research and development programs of the laboratory are: fundamental physical research, design and development of prototype nuclear weapons, the application of nuclear explosives to peaceful uses, studies of controlled fusion reactions, and the design and testing of nuclear reactors for propulsion systems. (N.W.R.)

6622 RADIOGRAPHY WITH THE ELECTRON LINEAR ACCELERATOR. S. A. Wenk and R. C. Marker (Applied Radiation Corp., Walnut Creek, Calif.). p.530-9 of "Proceedings of the Third International Conference on Nondestructive Testing, Tokyo & Osaka, March, 1960." Tokyo, Pan-Pacific Press, 1961. (In English)

Precision radiography of extremely thick sections of a wide variety of engineering materials such as steel and solid rocket propellants is being accomplished with the electron linear accelerator. These accelerators are used because of the combined capabilities of high energies and large radiographic articulation. The radiographic characteristics and the design of the accelerator are described along with the techniques used and the results obtained. (N.W.R.)

6623 RADIOGRAPHY OF PORCELAIN WITH A BETATRON. Tsunesaburo Asada (Osaka Univ.), Masayoshi Masuda, Masayuki Okumura, Juao Okuma, Yasuo Sasaki, Katsuzo Kita, and Yasuhiko Adachi. p.539-45 of "Proceedings of the Third International Conference on Nondestructive Testing, Tokyo & Osaka, March, 1960." Tokyo, Pan-Pacific Press, 1961. (In English)

The applications of x rays from a betatron for the radiography of porcelain products such as electric insulators and rotating and vibrating objects are described. In studying porcelain, minimum-size flaws can be detected as well as the sensitivity of the porcelain. For example, the sensitivity of a sample 10 cm in thickness using both 6 and 20 Mev x rays is 2%. In stroboscopic radiography the emission of x rays is synchronized with the rotating or vibrating object. If an object is rotating or vibrating with the same frequency as the a-c power source, the radiograph indicates the object is still. A high speed rotating machine may have some deformation as a result of centrifugal force. If the moving parts are observed from the outer side, the optical stroboscopic method will determine the deformation. This method is applicable to synchronous motors and other objects in motion. (N.W.R.)

6624 15 Mev LIGHT WEIGHT BETATRON AND APPLICATION TO NONDESTRUCTIVE TESTING. Hiroshi Kamogawa, Hatsutaro Nagami, Shun Sugimoto, Setsuo Nakamura, and Kyuji Fukatsu (Tokyo Shibaura Electric Co., Kawasaki, Japan). p.545-51 of "Proceedings of the Third International Conference on Nondestructive Testing, Tokyo & Osaka, March, 1960." Tokyo, Pan-Pacific Press, 1961. (In English)

A light weight (470 kg) 15-Mev betatron developed in Japan is described along with the techniques used in applying the device to nondestructive testing. The betatron is very compact and is a reliable source of very high energy x rays. The effective sectional area of the doughnut is expanded at the initial stage of acceleration which causes the magnet to increase circulating electron beams. Electron losses during acceleration are avoided by shifting the stable orbit from the center of the initial effective area to smaller radius in accordance with the reduction of the amplitude of the betatron oscillation and the increase of electron energy. The resolution of a magnified radiograph is studied from only one exposure which contains multiple data of the betatron radiography. The betatron is especially adapted to move in any direction in order that radiographs may be taken of extremely large vessels and containment shells. Some examples on nondestructive testing of cast, forged, welded, and enclosed systems are given to show practical applicability of the betatron in these fields. (N.W.R.)

GEOLOGY, MINERALOGY, AND METEOROLOGY

6625 (CEA-tr-R-1441) COPRECIPITANTS ORGANIQUES. XIV. UNE METHODE AMELIOREE DE COPRECIPITATION DE L'URANIUM DANS LES EAUX NATURELLES. (Organic Coprecipitants. XIV. An Improved Method of Coprecipitation of Uranium in Natural Waters). V. I. Kuznetsov (Kuznetzov) and T. G. Akimova. Translated into French from Radiokhimiya 2: 426-30 (1960). 17p. (Includes original, 5p.).

This paper was previously abstracted from the original language and appears in NSA, Vol. 15, abstract no. 2578.

6626 (GAT-Z-5022) RADIOACTIVE CONTAMINATION OF AIR AND WATER IN POLAND IN 1959. (Skazenia Radioktywne Powietrza i Wody w Polsce w 1959 Roku). (Poland. Panstwowa Rada do Spraw Pokojowego Wykorzystania Energii Jadrowej, Warsaw). Translated by R. P. Ratay (Goodyear Atomic Corp., Portsmouth, Ohio) from report NP-9934. 1960. 109p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 15, abstract no. 31000.

6627 TECTONISM, HYDROTHERMAL ZONING, AND URANIUM IN THE CENTRAL ANDES. [PART] I. John W. Gabelman (U. S. Atomic Energy Commission, Washington, D. C.). Bol. inform. junta control energiá atómica (Peru), 6: 25-41(July-Aug. 1961). (In Spanish)

The tectonism in the central Andes is discussed with a consideration of the general principles, the Andean system, compressive deformation, "stock" intrusions, "puna" erosion, volcanism, regional leaching, and block falling of the Cadena coast. Only the general principles and the concept of distrital zoning are described in the section on hydrothermal zoning. (J.S.R.)

6628 THE DIRECT STUDY OF THE CONTAMINATION OF SOILS IN THE FIELD BY AN AUTORADIOGRAPHIC METHOD. P. Bovard and A. Grauby. Bull. inform. sci. et tech. (Paris), No. 53, 2-6(July-Aug. 1961). (In French)

The autoradiographic method gives definite information on the behavior of a radioisotope in a given soil. This method and the results obtained with it are briefly discussed. (J.S.R.)

6629 GRANULOMETRIC DISTRIBUTIONS OF THE RADIOACTIVITY OF NATURAL AEROSOLS. Jean Bricard, Jacques Pradel, and André Renoux (Faculté des Sciences, Paris and Commissariat à l'Energie Atomique, Paris). Compt. rend., 253: 1476-8(Oct. 2, 1961). (In French)

The granulometric distribution of the radioactivity of natural aerosols in the submicronic region obtained during a series of measurements made in air is indicated, and evidence is given of a category of electrically neutral particles of the same dimensions as the average large ions, thus fixing approximately the layers of air radioactivity. (tr-auth)

6630 CONTENT OF THE NATURAL ISOTOPE BERYLLIUM-7 IN THE ATMOSPHERE AT HEIGHTS OF 9–10 KILOMETERS. N. T. Polyakov and L. E. Smirnov. Geokhimiya, No. 11, 967-70(1961). (In Russian)

In 1960 aerosol samples were taken at 9 to 13 km altitudes. The samples were investigated with the aid of a scintillation γ spectrometer. At 10 km the Be^7 concentration was 245 ± 60 atoms/liter. The experimental data approach calculated values. (auth)

6631 ON THE CALCULATION OF THE AGE OF THE EARTH CRUST WITH THE RUBIDIUM–STRONTIUM METHOD. Yu. A. Shukolyukov (Lab. of the Geology of Precambrian, Academy of Sciences, Moscow). Geokhimiya, No. 11, 1023-6(1961). (In Russian)

The age of the earth's crust was calculated according to the usual formula, using the following data: $\lambda\ Rb^{87} = 1.39 \times 10^{-11}\ year^{-1}$, $Rb^{85}/Rb^{87} = 2.59$, recent ratio Sr^{87}/Sr (average from data of various laboratories) is 0.0704, the ratio Sr^{87}/Sr in the protogenic (meteorite) strontium is 0.0675, the abundance of Rb in the crust of the earth is 0.0072%, the abundance of Sr is 0.045%. The value of the crust age $(4.5 \pm 1.0) \times 10^9$ years was obtained. According to the change of the Sr^{87}/Sr ratio in sedimentary rocks the age of the earth's crust is $(5.1 \pm 0.6) \times 10^9$ years. The average value according to two calculation methods is $(4.8 \pm 0.8) \times 10^9$. (auth)

6632 THE RELATIONSHIP BETWEEN THE U CONCENTRATION IN ZIRCON, MONAZITE AND TITANATES AND THE ALTERATIONS IN THESE MINERALS. V. I. Baranov and Le t'ien Tu (Moscow State Univ.). Geokhimiya, No. 11, 1029-31(1961). (In Russian)

A certain relation was established between crystalline changes and uranium content. An increased U content results in altered crystals due to secondary enrichment.(R.V.J.)

6633 ABSOLUTE AGE OF ROCKS IN MIRNYI REGION IN ANTARCTICA. A. Ya. Krylov, Yu. I. Silin, L. Ya. Atrashenok, and A. V. Lovtsyus. Geokhimiya, No. 11, 1034-5(1961). (In Russian)

The absolute age of the rocks in the Mirnyi region was estimated to be 4.7 to 5.0×10^8 years. (R.V.J.)

6634 RADIOACTIVITY OF SOME ITALIAN THERMAL WATERS. L. Argiero, A. Cigna, S. Manfredini, and G. Palmas (CAMEN, Leghorn). Minerva nucleare, 5: 187-91(Aug. 1961). (In Italian)

The radioactivity of thermal water from Lurisia, Acqui Terme, and Ischia was measured. The results of measurements of the following factors are presented: radioactivity due to radon, determination of RaD, gamma spectrography, and determination of local dose rate. (auth)

6635 CONSIDERATIONS ON THE MEASUREMENT OF THE RADIOACTIVITY IN THE AIR IN THE LIVORNO REGION. L. Argiero, S. Manfredini, and G. Palmas (CAMEN, Leghorn). Minerva nucleare, 5: 191-2(Aug. 1961). (In Italian)

The average weekly values for the radioactivity of the air as measured in Leghorn from June 1957 to June 1960 are reported. The relationships between the observed values and atomic explosions in the USA, USSR, and UK during this period are considered. (auth)

6636 RADIOACTIVITY IN CERVIDAE ANTLERS. H. Foreman, M. B. Roberts, and E. H. Lilly (Los Alamos Scientific Lab., N. Mex.). Z. Physik, 164: 537-45(1961). (In English)

The experience gained indicated that Cervidae antlers afford a convenient means for measuring levels of ambient radioactivity over large areas. By the use of antlers, it was possible to compare Sr^{90} levels resulting from bomb testing "fallout" year by year from 1943 through 1958 in a number of areas in the United States, Canada, and Alaska. The most surprising finding was the very high levels for Alaska in 1958. From calculations based on total beta counts in antlers, it was possible to show that the radiation dose delivered to bone from short-lived fission products is insignificant as compared to the dose delivered by Sr^{90}/Y^{90}.(auth)

HEALTH AND SAFETY

Refer also to abstracts 6256, 6916, and 7266

6637 (A/AC.82/G/L.663) REPORT ON EXPOSURE OF WORKERS OF ATOMIC ENERGY ESTABLISHMENT OF THE UNITED ARAB REPUBLIC. M. M. Mahfouz, I. R. Atiyah, and M. A. Ayad (United Arab Republic. Atomic Energy Establishment, Inshas, Egypt). Aug. 1961. 6p.

Detailed records since 1959 on the radiation exposure of all workers of the Atomic Energy Establishment of the United Arab Republic are reported. All workers are provided with film badges and pocket dosimeters. (C.H.)

6638 (APEX-344) D 102-A HAZARDS REPORT. C. C. Gamertsfelder, B. Blumberg, and T. W. Schoenberger (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Dec. 12, 1957. Decl. June 16, 1961. Contract [AT(11-1)-171]. 210p.

The D102-A reactor system is described and an evaluation made of the hazards of the HCE and HTRE #3 runs to be made with this system. (D.L.C.)

6639 (DASA-1300(Vol.1)) THE HIGH ALTITUDE SAMPLING PROGRAM. VOLUME 1. HASP PURPOSE AND METHODS. Final Report. James P. Friend, Herbert W. Feely, Philip W. Krey, Jerome Spar, and Alan Walton (Isotopes, Inc., Westwood, N. J.). Aug. 31, 1961. Contract DA-29-044-XZ-609.

High flying long-range aircraft were used to collect filter samples of stratospheric air, to altitudes of 70,000 ft, in a meridional sampling corridor. The samplers and the filter medium were calibrated to permit accurate determination of the volumes of sampled air. About 3700 filter samples were collected and analyzed between Aug. 1957 and June 1960. An ion-exchange technique was used to measure the first few hundred samples received, but carrier radiochemistry was used on all subsequent samples. Virtually all were analyzed for total beta activity and Sr^{90} concentration. More than 300 analyses were made of each of the hazardous nuclides Cs^{137} and Pu. Shorter-lived fission products were also measured in all samples to determine the age and origin of the debris which they contained. Many samples collected before 1958 were assayed for Ba^{140}. Almost all samples collected before mid-1959 were assayed for Sr^{89} or Zr^{95}, and a few were also analyzed for Y^{91}. Measurements of Ce^{144} were made on some samples collected during 1958 and 1959 and on most collected during 1960. One of the Hardtack tracers, W^{185} or W^{181}, was measured in almost every sample collected after May 1958. Many samples collected during the period of Dec. 1959 to June 1960, and a few collected earlier, were analyzed for Rh^{102}, the tracer for an Aug. 1958 rocket shot. Analyses were made on many samples collected during late 1959 and early 1960 for cosmic ray produced Be^{7}, and analyses of P^{32} were made on a few samples, in order to trace stratospheric mixing processes. The sampling program and all techniques employed are described. (C.H.)

6640 (DASA-1300(Vol.2A)) THE HIGH ALTITUDE SAMPLING PROGRAM. VOLUME 2A. RESULTS OF FILTER ANALYSES (LESS TABLE 4.3 AND FLIGHT CROSS-SECTIONS). Final Report. James P. Friend, Herbert W. Feely, Philip W. Krey, Jerome Spar, and Alan Walton (Isotopes, Inc., Westwood, N. J.). Aug. 31, 1961. Contract DA-29-044-XZ-609. 216p.

Data are tabulated on the radioactivity of stratospheric dust from more than 3600 filter samples analyzed radiochemically for various constituents of radioactive debris from nuclear weapon tests. Flight cross sections, on which are plotted the observed Sr^{90} concentrations, and some of the important flight data from the sampling missions are included. (C.H.)

6641 (DASA-1300(Vol.2B) THE HIGH ALTITUDE SAMPLING PROGRAM. VOLUME 2B. RESULTS OF FILTER ANALYSES (TABLE 4.3 AND FLIGHT CROSS-SECTIONS ONLY). Final Report. James P. Friend, Herbert W. Feely, Philip W. Krey, Jerome Spar, and Alan Walton (Isotopes, Inc., Westwood, N. J.). Aug. 31, 1961. Contract DA-29-044-XZ-609. 531p.

Flight cross-sections are presented for the high-altitude air sampling program, Aug. 1957 to June 1960. Data are included on the latitude and altitude of each flight, total β activity of samples collected, and concentrations of specific nuclides in each sample. (C.H.)

6642 (DASA-1300(Vol.3)) THE HIGH ALTITUDE SAMPLING PROGRAM. VOLUME 3. DISCUSSION OF HASP RESULTS. Final Report. James P. Friend, Herbert W. Feely, Philip W. Krey, Jerome Spar, and Alan Walton (Isotopes, Inc., Westwood, N. J.). Aug. 31, 1961. Contract DA-29-044-XZ-609. 315p.

Data are presented on the distribution in the stratosphere of each of the nuclides measured on filter samples collected during the period 1957 to 1960. Included are fission products, activation products, and cosmic ray products. Results are presented as a function of latitude, altitude, and time. The burdens of some of the long-lived nuclides in the stratosphere are calculated, using the observed distributions. Some of the implications of these distributions for possible mixing and transfer processes in the stratosphere are discussed. (C.H.)

6643 (DASA-1300(Vol.4)) THE HIGH ALTITUDE SAMPLING PROGRAM. VOLUME 4. THE APPLICATION OF HASP DATA. Final Report. James P. Friend, Herbert W. Feely, Philip W. Krey, Jerome Spar, and Alan Walton (Isotopes, Inc., Westwood, N. J.). Aug. 31, 1961. Contract DA-29-044-XZ-609. 154p.

Assessments are presented on the rate at which radioactive debris from world-wide fall-out is deposited on the earth's surface following the detonations of high-yield nuclear weapons. Emphasis is placed on past and future surface burdens of Sr^{90} and W^{185} and their variations with time. Five alternative methods for the calculation of the surface burden of world-wide fall-out are outlined and discussed. Four of the methods include the use of precipitation data in conjunction with the results of analyses of soils for radioactive fall-out. Since radioactive fall-out is deposited on the earth's surface primarily as precipitation, it is believed that these four approaches yield more accurate estimates of the total surface burden. The other approach to the determination of the surface burden of nuclear fall-out involves the measurement of the concentration's of radionuclides on the land and in the oceans. (C.H.)

6644 (DASA-1300(Vol.5)) THE HIGH ALTITUDE SAMPLING PROGRAM. VOLUME 5. SUPPLEMENTARY HASP STUDIES. Final Report. James P. Friend, Herbert W. Feely, Philip W. Krey, Jerome Spar, and Alan Walton (Isotopes, Inc., Westwood, N. J.). Aug. 31, 1961. Contract DA-29-044-XZ-609. 325p.

Methods used for the collection and analysis of stratospheric particles are described. Properties of stratospheric aerosols are discussed. Results are included from measurements of fall-out in man's environment. Topics discussed include measurements of C^{14} in tropospheric air, measurements of tritium in precipitation, the distribution of radioactivity in soils, and radiochemical data. Conclusions are drawn regarding the deposition of Sr^{90}, Ru^{106}, Cs^{137}, and Ce^{144} in soils. (C.H.)

6645 (HASL-117) FALLOUT PROGRAM—QUARTERLY SUMMARY REPORT, SEPTEMBER 1, 1961 THROUGH DECEMBER 1, 1961. Edward P. Hardy, Jr., Joseph Rivera, and Robert Frankel (New York Operations Office. Health and Safety Lab., AEC). Dec. 30, 1961. 255p.

Current data are presented from the HASL Fallout Program, the U. S. Naval Research Laboratory, the New Zealand Department of Scientific and Industrial Research, and the New Zealand Dominion X-Ray and Radium Laboratory. Radionuclide levels in deposited fallout, soil, water, and milk are given in tabular form. Interpretive reports and notes dealing with fallout and atmospheric radioactivity levels, gamma dose measurements, strontium-90 levels in diets, analytical reproducibility, and radioactive decay of weapons debris, are included. All interpretive reports and notes that have appeared in these quarterlies are cross-indexed by author and subject. A bibliography of recent literature pertinent to fallout studies is given at the end of the report. (auth)

6646 (NP-11228) RADIO-AKTIEVE SMETSTOFFEN EN DE VOEDSELVOORZIENING. (Radioactive Contaminants and Food Supply). H. Broeshart (Netherlands. Instituut voor Toepassing van Atoomenergie in de Landbouw, Wageningen). June 1961. 76p. (ITAL-1)

On the basis of data from the literature, a survey is given of the various mechanisms which play a role in the contamination of food supplies with radioactive waste products. The contamination concentrations in the foods were drawn up for various regions. Methods for the prevention or control of contamination of food materials are discussed. (J.S.R.)

6647 (TID-13523) ENVIRONMENTAL RADIATION MONITORING QUARTERLY REPORT. Second Quarter—1961, April—May—June. (Duquesne Light Co., Shippingport, Penna.). Contract [AT(11-1)-292]. 20p.

The radioactive content of the fall-out, river water, and vegetation samples increased from the previous quarter but the measurements were in line with the 1960 results. The radioactive content of the soil samples and the continuous measurements by the area monitors remained about the same. (auth)

6648 (DEG-Inf.Ser-26) THE DISTRIBUTION OF RADIOACTIVE PARTICLES AND THE INHALATION OF RADIOACTIVE AEROSOLS. W. Herbst. Translated by J. McDonald (U.K.A.E.A. Development and Engineering Group, Risley, Lancs, Eng.) from Atomkernenergie, 4: 300-5(1959). 14p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract no. 19089.

6649 (DEG-Inf. Ser.-199) METHODS OF CONTROL AND DECONTAMINATION FOR AEROSOLS AND RADIOACTIVE GASES. A. Facchini and M. Mandelli Bettoni. Translated by J. C. Ruckman (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.) from Energia elettrica, 37: No. 1, 52-65(1960). 29p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 15, abstract no. 29560.

6650 (JPRS-11776) PROTECTION OF PERSONS ASSISTING IN RADIUM APPLICATION. W. Alberti and K. Alberti. Translated from Neoplasma, 8: 323-9(1961). 7p.

Designs are presented for a shielded chair and shielded operating table for the protection of medical personnel during the application of radium to patients. Results of measurements indicate that the radiation dose to medical personnel is reduced to about one twentieth of its magnitude by this equipment. (C.H.)

6651 THE RADIOACTIVITY OF ATMOSPHERIC PRECIPITATION. V. Mageru, D. Blănariu, and I. Gabe (Academie R. P. R., Jassy). Acad. rĕp. populaire Roumaine, Rev. phys., 6: 23-9(1961). (In German)

The results of measurements made on the radioactivity of atmospheric precipitation in 1959 were reported. The precipitation was collected daily, and the β activity was determined. Chemical, radiochemical, and spectrographic investigations of the dry residues of the precipitation were also made. The radioactivity found was tabulated for each month. (J.S.R.)

6652 DESIGN FOR SURVIVAL. Philip Will, Jr. Architectural Record, 127-34(Jan. 1962).

The design and protection of fall-out shelters are presented. The type of material to use and the protection it provides is discussed. The human needs and the capacity required for an individual over various periods of time are discussed. The design requirements for an office building are also discussed. (N.W.R.)

6653 SURFACE DECONTAMINATION. E. Mestre (Commissariat à l'Énergie Atomique, [Paris]). Énergie nucléaire, 3: 309-18(Sept.-Oct. 1961). (In French)

Surface decontamination is undertaken to eliminate irradiation risks to personnel and to recover material whose replacement cost is very high. The study of decontamination processes, which depend both on the nature of the radioactive substance and the nature of the contaminated surface, are described. These studies were preceded by contamination tests, made to determine the factors that govern the process. On the basis of the results it was possible to select the most convenient decontamination process and the materials least likely to retain surface contamination. The decontamination procedures used at Saclay are described. (tr-auth)

6654 RADIATION PROTECTION MEASUREMENTS AT VARIOUS EUROPEAN BETATRON INSTALLATIONS. J. Kretschko, H. Liesem, W. Pohlit, S. Rase, and A. Sewkor (Max-Planck-Institut für Biophysik, Frankfurt am Main). Fortschr. Gebiete Röntgenstrahlen u. Nuklearmed., 95: 565-72(Oct. 1961). (In German)

In connection with comparative measurements on dosimeters used in therapy at various European betatrons the distribution was measured also of the unwanted bremsstrahlung and of fast neutrons. As bremsstrahlung detector use was made of a portable cylindrical ionization chamber. The results show that the distribution of the unwanted bremsstrahlung depends on the construction of the betatron. The measurement of the fast neutrons produced by nuclear photoeffects was carried out on a paraffin double moderator by means of a BF_3 counter. In this way it was possible to determine either the neutron dose rate or flux density and so to establish the mean neutron energy. The distribution of the fast neutrons is determined by the shape and dimensions of the therapy room. The measurements thus provide important clues for a suitable construction of therapy rooms. (auth)

6655 AIR-EQUIVALENT MATERIALS FOR γ-RAY DOSIMETRY FROM 10 KEV TO 50 MEV. G. Joyet, E. Hugentobler, and A. Mysyrowicz (Betatron and Isotopes Lab., Zurich). Helv. Phys. Acta, 34: 414-20(1961). (In English)

An expression is given for μ_a (the true absorption coefficient) and the expression was used to calculate the absorption coefficients for H, C, N, O, Mg, Al, Ar, and K. The values for Cl were determined through precise interpolation in known cross sections, and these values were tabulated for energies from 0.1 to 50 Mev. The air equivalences of mixtures C + Al_2O_3, Araldite D + plexiglass + Al_2O_3, and plexiglass + vinyl chloride in definite proportions were determined and shown graphically. (J.S.R.)

6656 BENZENE IN WATER IS SIMPLE, RELIABLE GAMMA DOSIMETER. Terry R. Johnson and Joseph J. Martin (Univ. of Michigan, Ann Arbor). Nucleonics, 20: No. 1, 83-5(Jan. 1962).

Studies were made on benzene-water systems for use as gamma dosimeters. Particular attention is given to the phenol concentration and the probable mechanisms produced in the solution. Results show that the benzene-water dosimeter is easier to use than the ferrous sulfate-sulfuric acid dosimeter and, in some respects, is more reliable. For instance the benzene-water dosimeter gives consistent results even with impure reagents and other ions can be added (for example, those used as neutron detectors). Also, benzene-water and the phenol produced by gamma-irradiation are much less corrosive than 0.8 N sulfuric acid and so can be contained safely in metal as well as glass or plastic. The solution is stable for long times both before and after irradiation. (N.W.R.)

6657 THE CONCEPT OF ABSORBED ENERGY AND MODERN DOSIMETRIC DEFINITIONS. F. Bistolfi (Università, Genova, Italy). Radiol. med., 47: 785-814(Sept. 1961). (In Italian)

First, attention is drawn to the fundamental definitions of force, weight, mass, work, energy, power, and the pertinent units of measurements in the cgs system. Particularly attention is given to the erg and its relation with ev and Mev units, the mechanical equivalent of calories, and the unit of absorbed dose, the rad. In the second part the general calculation of the energy absorbed in air and tissues on exposure to a given dose of x and gamma rays is given, and the various quantities and units of measurement accepted today are reviewed. Finally, the strict relationships between LET, linear ionic density, RBE, and rem are discussed. (auth)

6658 FLUOROD DOSIMETRY CLOSE TO RADIUM AND COBALT-60 SOURCES. Milton Friedman, Morris Hodara, and Gerald J. Hine (Hospital for Joint Diseases, New York and Veterans Administration Hospital, Boston). Radiology, 78: 29-43(Jan. 1962).

Point-dose measurements were made around a variety of radium and cobalt-60 solid discrete sources with the aid of fluorods (miniature glass rod dosimeters). The measured values are in good agreement with the calculated values in the literature. With the fluorod, dose distributions in regions close to radioactive sources could be measured to provide data not previously reported. Radiation fields inside of and around multiple source implants were mapped in detail, and information of clinical value was derived. Whereas the hot spot close to a single radium needle was intense, the presence of additional sources in a multiple needle implant was found to reduce the relative dose rate at this point. In a volume implant consisting of three needles crossed at both inactive ends, the actual shape of the irradiated volume appears as a spheroid, with one diameter larger than that of the hypothetical cuboid on which the implanted volume was originally constructed. Dose distributions around small (3 to 5 mm diameter) Co^{60} spheres were found to approximate the inverse-square-law distribution. For a larger sphere (20 mm diameter), fluorod measurements coincided with the data calculated with Mayneord's formula for extended sources. Dose distributions around a few multiple-source brachytherapy devices were measured. (auth)

6659 ACCURACY OF FLUOROD DOSE MEASUREMENTS. Gerald J. Hine, Morris Hodara, and Milton Friedman (Hospital for Joint Diseases, New York and Veterans Administration Hospital, Boston). Radiology, 78: 44-8 (Jan. 1962).

A large number of fluorods, from 71 to 137 at a time, were exposed simultaneously to a homogeneous 2 Mvp x-ray beam. The fluorods were placed in a large water phantom, 5 cm below the surface of the water, at the center of a 20 × 20 cm field at a TSD of 100 cm. This method of exposure assured an equal dose to all fluorods in each set. Six sets of fluorods were so irradiated with measured doses ranging from 155 to 2795 rads. The standard deviation for the 6 sets ranged from 5.2 to 9.5% of the mean dose. It was concluded that no statement can be made concerning the accuracy of a single fluorod measurement. For each dose determination several fluorods must be used and the average dose value determined. For a standard deviation of 6%, it can be shown that the average measurement of 4 fluorods is required to achieve an accuracy of 5% with a 90% confidence limit. (P.C.H.)

6660 ON THE USE OF THIMBLE CHAMBERS IN PHANTOMS. Gail D. Adams (Univ. of California, San Francisco). Radiology, 78: 77-90(Jan. 1962).

The results are given of investigations on the validity of the assumption that the thimble chamber will record faithfully (within 5%) the exposure dose delivered at the position of the center of a chamber. The Victoreen condenser r-meter was examined over a wide range of quality and other physical factors. A detailed discussion is given on corrections applicable to readings obtained in phantoms and on corrections applicable to readings resulting from exposures in air. The experiments involved measurements in air and at various depths in a Presdwood phantom, with Victoreen thimbles of nominal range 25, 100, 250, and 1000 r, for two field sizes, and for nine radiation qualities. It was concluded that owing to absorption of both primary and secondary radiation in the brass barrel of the thimble, the reading is reduced below that which would otherwise be observed, and by an amount ranging up to 9% for the conditions studied. The correction required was shown to depend on quality, field size, and depth in the phantom, but only slightly on thimble range. Correction graphs are included. The data presented display a pattern which is felt to be consistent and in agreement with a qualitative argument quoted. (P.C.H.)

6661 X-RAY DOSE MEASUREMENTS IN THE GONAD REGION OF AN INFANT PHANTOM UNDER SUPERFICIAL RADIATION CONDITIONS. Willi Born (Universitäts-Hautklinik, Freiburg i. B.). Strahlentherapie, 116: 311-19 (Oct. 1961). (In German)

Gonadal dose measurements on a paraffin phantom, done under the superficial radiation conditions of van der Plaats, show to what extent a different topographical position of the radiation field, different aperture angles, exit apertures of the tube, focal skin distances, and direction of the central rays and the whole beam effect the gonadal charge con-

nected with each therapy situation. The rules worked out show which conditions lead to a lessening or increasing of the gonadal charge; the height of each of the test values explains how each change is to be valued, whether it is more or less decisive for the total situation. Results for other radiation sources are extremely analogous, but characteristic for each source. These results call for an increased consideration of radioprotection methods during the use of $Sr^{90} \rightarrow Y^{90}$. (auth)

6662 RELIABILITY OF FILM BADGE METHOD AND POCKET DOSIMETERS FOR PERSONNEL MONITORING. Masashi Fukuda (Kyoto Univ.), Tsutomu Sugahara, and Tetsuaki Hashimoto. Strahlentherapie, 116: 638-45(Dec. 1961). (In English)

The discordance in the values obtained by the film badges and pocket dosimeters as routinely used in Japan were studied. According to the tests in a factory manufacturing various kinds of radiation apparatus, it was concluded that the most important cause seemed to be an accumulation of the minimum detectable value different for both methods. (auth)

6663 SOME DATA ON THE QUALITY OF SCATTERED RADIATION IN ROENTGENOLOGICAL INVESTIGATIONS. B. M. Aliev (Central Graduate Medical Inst. and State Roentgen-Radiological Scientific-Research Inst., Ministry of Public Health, USSR). Vestnik Rentgenol. i Radiol., 36: No. 6, 34-8(Nov.-Dec. 1961). (In Russian)

The quality and the quantity of scattered radiation was studied on a paraffin phantom in conditions of diagnostic regimens. An RM-1 high-sensitivity dosimeter and an especially made ionization chamber were used. The sensitivity of this dosimeter was increased 300 fold. As established the half-value layer of scattered radiation outside the straight beam is greater than that of the incident beam in diagnostic voltages with a 2 mm Al primary filter. The half-value layer of scattered radiation depends on the hardness of the incident beam and is not dependent upon the volume of the tissues irradiated. Scattered radiation outside the straight beam is more uniform than the incoming radiation. The data obtained may be used for calculating the integral absorbed doses. (auth)

6664 IONIZING RADIATION AND HEALTH. WHO (World Health Organization) Chronicle, 15: 435-8(Dec. 1961). (In English)

Sources of ionizing radiation to which man is exposed are reviewed from the viewpoint of immediate and long-range biological effects. (C.H.)

6665 RADIATION PROTECTION. WHO (World Health Organization) Chronicle, 15: 438-42(Dec. 1961). (In English)

The protection of mankind from ionizing radiation was discussed at the Thirteenth World Health Assembly in 1960, and it was resolved that national health authorities should be encouraged and assisted by WHO to recognize the importance of the role they should play and increase their activities in this field. The Director-General was asked to report to the Fourteenth World Health Assembly on progress in developing and staffing radiation control programs, with particular reference to the responsibility of national health authorities and WHO. (auth)

6666 HEALTH HAZARDS FROM NUCLEAR-POWERED MERCHANT SHIPS. WHO (World Health Organization) Chronicle, 15: 442-4(Dec. 1961). (In English)

An aspect of radiation protection that is likely to receive increasing attention is the danger to health from nuclear-powered ships. At present this danger is slight, since such ships are few; but many more will be built in the near future. A report on the subject submitted by the Director-General of WHO to the Fourteenth World Health Assembly is summarized. (C.H.)

6667 ACCIDENTAL RADIATION INJURY. WHO (World Health Organization) Chronicle, 15: 445-52(Dec. 1961). (In English)

Studies of the effects of ionizing radiations in animals are of limited value for human medicine as the results cannot be reliably extrapolated to man. It is therefore essential to extract the maximum amount of information from the relatively few observations on persons accidentally exposed to high doses of radiation and those deliberately irradiated under medical supervision for therapeutic purposes. With this aim in view, IAEA and WHO, which have a common interest in radiation medicine, jointly sponsored a Scientific Meeting bringing together three groups of scientists: those with experience in the treatment of persons accidentally exposed to high doses of radiation; those employing large doses of whole-body irradiation for therapeutic purposes; and those working on related programs in experimental animals. Some of the work relating to accidental radiation injury is discussed. (C.H.)

6668 MANAGEMENT OF RADIATION CASUALITIES. WHO (World Health Organization) Chronicle, 15: 453-60 (Dec. 1961). (In English)

Radiation accidents have, to date, given rise to 8 cases of acute radiation syndrome which resulted in death. Clinical and pathological findings in these cases are reviewed. Difficulties in correlation of the clinical findings with dose are discussed. Procedures used in the symptomatic treatment of radiation injuries are reviewed. The value of bone marrow grafts is discussed. (C.H.)

6669 THERAPEUTIC USES OF RADIATION INJURY. WHO (World Health Organization) Chronicle, 15: 461-4 (Dec. 1961). (In English)

Much valuable information regarding the effects of large doses of whole-body irradiation and the treatment of acute radiation injury can be obtained from the study of patients deliberately irradiated for therapeutic purposes. Of particular interest in this connection are the irradiation of patients in preparation for kidney transplantation and the treatment of leukemia by combined irradiation and bone marrow transfusions. Findings in the patients are reviewed which confirm and complement those in accidentally irradiated patients. (C.H.)

6670 VITAL AND HEALTH STATISTICS IN GENETIC AND RADIATION STUDIES. WHO (World Health Orginization) Chronicle, 15: 465-72(Dec. 1961). (In English)

The techniques for large-scale studies of various aspects of human population genetics are still in their infancy. It is likely that for years to come, each large-scale study undertaken will be encountering field problems and statistical questions not previously solved. It is difficult to envisage a study on human radiation genetics which would not yield information on a variety of other topics of interest to human biologists. Information will also accumulate concerning the total impact of hereditary disease on the populations under study, as well as data concerning mutation rates and other specific items of general genetic interest. (auth)

6671 VÉDEKEZÉS ATOMMAGSUGÁRZÁS ELLEN. (Protection Against Nuclear Radiations). 2nd Edition. László Bozóky. Budapest, Technical Publishing House, 1960. 271p.

After reviewing the basic principles of radioactive decay

and artificially induced radioactivity, the interaction between radiation and matter is discussed in detail. Absorption, shielding and scattering phenomena are presented, describing practical experiments in the field. Special attention is given to dose units, biological effects, instrumentation and rate calculations. The problems of protection of workers and of the population at large are considered on the basis of recent publications of the International Atomic Energy Agency. The technical problems of radioactive waste disposal and of the transportation of radioactive materials are discussed. The work is recommended as a general textbook and reference for specialists. (TTT)

6672 PROTECTIVE CLOTHING AND OTHER APPAREL. OTS Selective Bibliography. (Office of Technical Services, Washington, D. C.). Oct. 1961. 12p. (SB-482). $0.10(OTS).

A bibliography on protective clothing and other apparel is presented. The 158 references were added to the Office of Technical Services collection during the period 1950 to October 1961. (M.C.G.)

INDUSTRIAL APPLICATIONS OF ISOTOPES AND RADIATIONS

Refer also to abstracts 6365, 7260, and 7262

6673 (JPRS-11691) THE PRESENT STATE AND POSSIBILITIES OF USING RADIOACTIVE ISOTOPES IN HUNGARY. Pal Tetenyi. Translated from Magyar Tudomany, 68: 455-66(July-Aug. 1961). 15p.

Applications of radioisotopes in Hungary during 1961 are reviewed. Topics discussed include uses in scientific research, radiological testing of materials, activation analysis in industrial processes, radiation sources in geophysical research, measuring and control equipment, and industrial tracer applications. (C.H.)

6674 THE USE OF ION-EXCHANGE MATERIAL IN PREPARING LOW-ACTIVITY RADIATION SOURCES. B. A. Zaitsev, A. I. Grivkova, and M. P. Glazunov. Atomnaya Energ., 11: 431-4(Nov. 1961). (In Russian)

A sulfophenolformaldehyde cation exchange material KU−1G in the form of spheres 0.25 to 1.50 mm in diameter and in the form of film with polyethylene as a binding agent was used to prepare Cs^{137} sources. The Cs^{137} had a specific activity of 13 curies/g. After absorption from a 0.15 N solution of cesium chloride it was found that the resin had a specific activity of 9.8 curies/g on adsorption from a neutral solution, and 15.1 curies/g on adsorption from 0.032 N NaOH. One bead of ion-exchange material 1.50 mm in diameter can hold 35.5 millicuries of Cs^{137}. The ion-exchange membrane had a specific activity of 0.516 curies/cm^2. The method can be used to form radiation sources of a definite shape with a minimum amount of fines as a by-product. At a total dose of 4.38×10^{23} ev/gram, delivered to the organic ion-exchanger over a period of 180 days, it was found that 0.04 mm^3 of gas is evolved per day (this amount of gas corresponds to 2.9% of the volume of the ion-exchanger per day). The amount of gas evolved could be reduced by a factor of about four by heating the ion-exchanger at 400°C for 6 hours, instead of at 170°C, in order to remove water. The incorporation of 15 mg of palladium black in sources having a specific activity >1.2 curies/gram absorbed the hydrogen gas evolved, and eliminated the build-up of pressure in the source. (TTT)

6675 POSSIBILITY OF USING A NATURAL URANIUM SOURCE AS β EMITTER (UX_2) FOR THICKNESS MEASUREMENTS IN TESTS IN INDUSTRIAL LABORATORIES. Rafael Pérez del Viso (Universidad Nacional del Litoral, Santa Fe, Argentina). Rev. soc. quim. Méx., 5: 184-8 (Sept. 1961). (In Spanish)

UX_2 was investigated as source for the natural mixture of the descendents of U^{238} because of its cheapness, availableness, and preparation. Considering its low activity as the principal inconvenience, the highest intensities to be reached were calculated and as it is a laboratory method, we used G. M. tubes with thin walls. Different components of the radioactive mixture and their relative intensities, were discussed. There was also a theoretical discussion of the absorption process of the β rays in order to explain the influence in the absorption curve of the used geometry. In this work, absorption curves in aluminum were determined using different geometric dispositions searching that one, which gives a better approximation to the exponential law. With this purpose, the most convenient part of the curve was chosen, not the first part. Later on different materials were tested and it was concluded that an exponential absorption, with thickness of 0 to 120 mg/cm^2, can be obtained. In this way, the calibration of the instrument for any material was very simple. (auth)

6676 USE OF RADIOISOTOPES FOR TESTING REINFORCED CONCRETE. Karl Heinz Lucke (Institut für Baustoffe, Weimar, [Ger.]). Silikat Tech., No. 12, 562-3 (1960).

The radioisotopes used to test reinforced concrete were Co^{60} (for material of a thickness of 25 cm and more), Cs^{137}, Ir^{192} (for thin material), and Tm^{170}. Two Co^{60} preparations were used to study the position of three 10 mm thick steel wires embedded in 17-cm thick reinforced concrete. This was done either by measuring the intensity of rays passing through the concrete beam, using a counter and a preparation with an activity of 2.3 mc; or, when using a preparation with an activity of 50 mc, by representing the different radiation intensities on an Agfa-Texo-S film (exposure: 6-10 hrs) placed in a box and put on the beam. The position of the steel wires could be accurately determined in both cases. The tests will be continued with reinforced concrete floors. (OTS)

6677 RADIOMETRIC INVESTIGATION OF THE SINTERING AND THE WEAR OF OPEN-HEARTH FURNACE BOTTOMS. V. A. Machkovskii and M. M. Khil'ko (Makeevka Metallurgical Plant). Stal', 20: No. 11, 995-6(1960).

β emitters were placed at various depths in a furnace bottom. At each melting and before deoxidation (before the given isotope becomes effective) samples were taken and the wear of the bottom could be defined in millimeters of the melt. The rate of bottom-wear was plotted in graphs, showing that the optimum service life can be obtained with a sintered layer 50 mm thick. The isotope tests also revealed the chemical aspects of the process and enabled the establishment of optimum sintering conditions for the bottom, the method requires 4 hours, 40 minutes shorter than the conventional, and the furnace output is increased considerably. (OTS)

ISOTOPE SEPARATION

6678 (CEA-tr-A-837) PROCEDE D'ENRICHISSEMENT ISOTOPIQUE PAR ECHANGE DE MATIERE REALISE A DEUX TEMPERATURES DIFFERENTES. (Procedure for Isotopic Enrichment by Mass Exchange Made at Two Different Temperatures). E. Meurer and W. Weidgen. Translated into French from German Patent 1064919. [nd]. 15p.

An isotopic enrichment process by mass exchange at two temperatures between a liquid and a gas (used particularly for the preparation of heavy water using hydrogen sulfide) is described. In this process the liquid passes successively through a hot exchange column, while the gas circulating by counter current passes first through the hot column and then the cold column. The gaseous currents and the liquid current enter by the hot column and leave by the cold column, and they are in reciprocal contact in a heat exchanger. The process is characterized by the fact that the gas containing the hot evaporated liquid coming from the hot column is cooled directly by a primary auxiliary liquid. The auxiliary liquid is cooled indirectly by another auxiliary liquid. By means of this second liquid, the gas, before being introduced into the hot column, is heated directly and saturated. (tr-auth)

6679 THE SEPARATION OF LITHIUM ISOTOPES BY MOLECULAR DISTILLATION OF LIQUID LITHIUM METAL. V. A. Malyusov, V. Yu. Orlov, N. A. Malafeev, N. N. Umnik, and N. M. Zhavoronkov. Atomnaya Energ., 11: 435-9(Nov. 1961). (In Russian)

The theoretical separation factor for molecular distillation is given by the expression: $\alpha_M = (P_1/P_2)\,(\sqrt{M_2/M_1})$, where P_1 and P_2 are the vapor pressures, and M_1 and M_2 are the atomic weights of Li^6 and Li^7. Since $P_1/P_2 = 1.008$ to 1.009 (estimated from the characteristic Debye temperature and the triple point temperature), the separation factor should be about 1.09. Metallic lithium was distilled in a single-stage, stainless steel unit at a temperature of 490 to 500°C, and an experimental separation factor of 1.09 was found for the enrichment of Li^6 in the condensed vapor. A eight-stage molecular distillation unit was then built. It was found necessary to use metallic netting (30 mesh) in each cell in order to stabilize the levels of metal in each cell. Better results were obtained at a higher condensation temperature (340 to 350°C) as compared to the lower condensation temperature (265 to 270°C). The useful stage efficiency of the equipment was estimated to be 40 to 50%. (TTT)

6680 ISOTOPE SEPARATION WITH THE ELECTRICAL MASS FILTER. F. v. Busch and W. Paul (Universität, Bonn). Z. Physik, 164: 581-7(1961). (In German)

Studies on the separation of weighable masses of magnesium are reported. In enrichment of either of the rare isotopes (natural frequencies: Mg^{24} – 79%, Mg^{25} – 10%, and Mg^{26} – 11%), up to several hundred micrograms of the collected isotope can be obtained in a 10-hour separation procedure. Mg^{26} was enriched to 84% and Mg^{25} to 69% in separate experiments. Various sources of error and methods for the improvement of the apparatus were discussed. (tr-auth)

MATHEMATICS AND COMPUTERS

Refer also to abstract 6913

6681 (MND-C-2206) ANPP CODE DEVELOPMENT PROGRAM, PRESSURIZED WATER TASK, QUARTERLY PROGRESS REPORT NUMBER SEVEN. T. M. Olsen and L. Welshans (Martin Co. Nuclear Div., Baltimore). May 1961. Contract [AT(30-1)-2431]. 172p.

Progress for the seventh quarter of the ANPP Code Development Program is reported. The logical flow diagram for the burnup program, SYBURN, was completed. Seven of the required 21 subroutines were completed and checked out; an additional six subroutines were written. SYNFAR was used to analyze 12 clean, critical cores. Use of the diffusion theory option resulted in K-eff; approximately 1.5% low; use of the SN option resulted in a maximum error of 0.8%. Neutron lifetimes for several cores were calculated; values were in the range of 4 to 5 μsec. The clean core experiments were completed. Several cores, including Core 454, were rebuilt to utilize the latest experimental techniques or to obtain more consistent data. An investigation of basic pulsed neutron techniques was initiated in an attempt to improve agreement between period and pulsed neutron reactivity measurements. (auth)

6682 (TID-14470) A PROGRAM FOR THE COMPUTATION OF THERMAL STRESSES IN A LONG CYLINDER (HOLLOW OR SOLID); ANP PROGRAM NO. 0121. Harry B. Stigall (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Oct. 13, 1958. Contract [AT(11-1)171]. 35p. (DC-58-10-154)

The program, which is based on the analysis of A. L. Ross and R. R. McCready, computes the thermal stresses in a long cylinder (hollow or solid) for a prescribed temperature distribution specified at K = 30 equally spaced points. A Fourier series for the temperature was derived from these given values and this series was used for the computation of the temperatures (and hence the stresses and strains) at L = 30 equally spaced points in regions 1, 2, and 3. The integers K_1, K_2, and K_3 and L_1, L_2, and L_3 are part of the input which also includes the bounding radii of the regions and physical constants for each region. An identification symbol of up to 54 Hollerith characters may be stated as additional input. The integers K_1, K_2, and K_3 are the number of points at which the temperature is prescribed for each region across the radius. The integers L_1, L_2, and L_3 are the points at which output is desired for each region. The output includes all the input together with the computed temperatures at the K original points and at the L interpolated points. The Fourier coefficients are printed and, finally, the radial, axial, and tangential stresses and strains are posted by zones along side their corresponding radii. Details are given on the proper filling out of input sheets and on the operation of the program. (auth)

6683 DATA PROCESSING AND PROGRAMMING. OTS Selective Bibliography. (Office of Technical Services, Washington, D. C.). Aug. 1961. 26p. (SB-474). $0.10 (OTS).

A bibliography is presented of reports listed in U.S. Government Research Reports and Technical Translations during the period of 1959 to September 1961 covering the subjects of computer programming, data processing and transmission, data coding, and government-owned patents on data processing equipment. (C.H.)

METALS, CERAMICS, AND OTHER MATERIALS

General and Miscellaneous

6684 (ANL-6412) SOME METALLURGICAL APPLICATIONS OF AUTORADIOGRAPHY. Max D. Adams and Robert K. Steunenberg (Argonne National Lab., Ill.). Oct. 1961. Contract W-31-109-Eng-38. 32p.

Macro- and high-resolution methods for autoradiography were used to investigate a number of problems concerning the distribution of uranium and other active elements in metal specimens. Illustrations are presented of the behavior of some of these materials with various heating and cooling treatments and in the presence of metals with which intermetallic phases are formed. Techniques are discussed for handling and examining autoradiographic stripping films by means of various types of metallurgical and conventional microscopic equipment. (auth)

6685 (IS-262) ARC MELTING IN THE TUNGSTEN ELECTRODE FURNACE. D. E. Williams and H. L. Levingston (Ames Lab., Ames, Iowa). Nov. 1961. Contract W-7405-eng-82. 17p.

An arc furnace is described which employs a nonconsumable tungsten electrode and a water-cooled copper hearth. It is used successfully for melting refractory metals and alloys. The furnace is equipped with a vacuum system, an inert gas supply, and an 800-ampere direct-current power supply. (auth)

6686 (NDA-2162-5) CARBIDE FUEL DEVELOPMENT. Phase III Report, September 15, 1960–September 15, 1961. W. Sheridan and A. Strasser (United Nuclear Corp. Development Div., White Plains, N. Y.) and J. Anderson and K. Taylor (Carborundum Co., Niagara Falls, N. Y.). Sept. 30, 1961. Contract AT(30-1)-2303(IV). 64p.

UC–PuC solid solution powders containing only minor amounts of impurities were obtained by reacting a mixture of UO_2 and PuO_2 with carbon or by heating together a mixture of UC, Pu_2C_3, and U. UC–PuC pellets with the desired high densities of 95% of theoretical were obtained by cold pressing and sintering, using 0.1 wt % nickel as a sintering aid. Without nickel, the densities were much lower for the same sintering conditions. Prior to experiments with solid solution carbides, essentially stoichiometric UC powder was prepared in the plutonium facility by the carbon reduction of UO_2 in a helium atmosphere. Attempts to prepare stoichiometric PuC by the carbon reduction of PuO_2 failed, the product consisting of a mixture of plutonium carbides and oxides. Pu_2C_3 was readily obtained by reacting stoichiometric amounts of PuO_2 and carbon. Additional evaluation of test samples, using x-ray diffraction and a microprobe analyzer, confirmed that type 304 stainless steel, 2¼ Cr-1 Mo steel, and niobium are satisfactory UC cladding materials at 820°C, for 4000 hr, while Inconel-X, Zircaloy-2, and beryllium are not satisfactory. The irradiation of two clad UC specimens was completed. The UC pellets were made by cold pressing and sintering UC powder, which in turn was made by reacting UO_2 with carbon. Irradiation conditions were 18,500 Mwd/tonne average burnup, 760°C average central fuel temperature, and 315 w/cm average heat generation rate. In-pile measurements of the combined fuel plus helium gap conductivity gave an average value of 0.02 g-cal/sec-cm^2-°C/cm. The UC conductivity was similar to out-of-pile values for arc cast UC, if reasonable helium gap conductances were assumed. A glove box for high temperature property measurements was designed and is being assembled. A conceptual design of the facility for examining irradiated plutonium was made. (auth)

6687 (OTS-61-11429) PRODUCTION OF FERROALLOYS: ELECTROMETALLURGY. Second Edition. V. P. Elyutin, Yu. A. Pavlov, B. E. Levin, and E. M. Alekseev. Translation of "Proizdvodstov Ferrosplavov Electrometallurgiya" (a publication of The State Scientific and Technical Publishing House for Literature on Ferrous and Nonferrous Metallurgy, Moscow, 1957). 454p. (PST-Cat.-135).

Theoretical and practical data on the production of ferroalloys are classified and summarized. The theoretical principles and the technology of production of various ferroalloys are examined. To facilitate understanding of thermodynamic calculations, some information is given on physical chemistry. The economics of production of ferroalloys and safety procedures are also treated. A description of the technology and achievements of Soviet and foreign ferroalloy industry is given. (auth)

6688 DISCONTINUOUS CHARACTER OF THE ELEMENTARY PROCESS IN THE GRAPHITIZATION OF CARBON. Michel Oberlin and Jacques Mering (Institut National de Recherche Chimique Appliquée, Paris). Compt. rend., 253: 2549-51(Nov. 27, 1961). (In French)

A study of the wet-method oxidation of more or less graphitized C demonstrates the existence of three species of atomic strata in C and permits the analysis of these strata. (tr-auth)

6689 DETERMINATION OF GRAIN BOUNDARY DIFFUSION COEFFICIENTS WITH THE HELP OF RADIOACTIVE ISOTOPES BY MEASUREMENT OF THE INTEGRAL RESIDUAL ACTIVITY. A. Haessner and D. Bergner (Technische Hochschule, Dresden, Ger.). Isotopentechnik, 1: 193-5(Sept. 1961). (In German)

It was theoretically and experimentally shown that grain boundary diffusion coefficients can be determined by measuring the residual activity dependence on removed layer thickness. The logarithm of the residual activity changes linearly with the removed layer thickness. The slope of this line agrees with the slope of the line obtained if the logarithm of the specific activity of the chips removed from the sample surface is plotted against the penetration depth, as Fisher suggests. The method is especially advantageous for hard or brittle materials in the application of pure β emitters. (tr-auth)

Corrosion

6690 (DEG-Inf-Ser-112) THE EFFECT OF IMPURITIES ON THE RATE OF OXIDATION OF REACTOR GRADE GRAPHITE. S. Keraudy, F. M. Lang, P. Magnier, and S. May (France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay). Translated by V. J. Wilkinson (U.K.A.E.A. Development and Engineering Group, Risley, Lancs, Eng.). July 1, 1959. 23p. (DPC.CPh/59-711)

Reactor grade graphites contain impurities which increase their rate of oxidation in air. Autoradiography and spectrographic analysis have allowed the presence of about twenty elements to be detected, the majority being extremely localized. We have studied the action of some of them by introducing them (in the form of aqueous solutions

or powders) into purified reactor grade graphite. Since these elements had not undergone the same heat treatment as the impurities contained in reactor grade graphite, we could only consider our results as a rough measurement to act as a basis for further work. Compounds of vanadium, copper, sodium, and iron have a powerful effect. The combination of compounds of vanadium and sodium produces distinctly more oxidation than that estimated from the addition of the effects of these compounds taken separately. In the case of Péchiney graphite, in which these two elements co-exist at certain points, the local large increase in oxidation leads to the formation of pits. (auth)

Fabrication

6691 (APEX-306) PRELIMINARY EVALUATION OF FABRICATION METHODS FOR CLAD HYDRIDED-ZIRCONIUM MODERATOR SECTIONS. Coy L. Huffine (General Electric Co. Aircraft Nuclear Propulsion Dept. Cincinnati). June 30, 1955. Decl. June 9, 1961. Contracts AF33(038)-21102 and AT(11-1)-171. 21p.

A preliminary evaluation of fabrication methods for producing clad moderator sections of hydrided zirconium is described. Four cladding methods are evaluated, and the development effort necessary for determination of the most feasible process is outlined. (auth)

6692 (ASD-TR-7-886(III)) DEVELOPMENT OF 2400°F FORGING DIE SYSTEM. Interim Technical Progress Report, September 28–December 27, 1961. H. Nudelman, A. H. Murphy, T. Watmough, and P. R. Gouwens (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Jan. 1962. Contract AF33(600)-42861. 29p.

A hot die system to evaluate the upper operating temperature limit of Inconel 713C forging dies is ready for forging. Redesigned dies are partially prepared to use a hot die extrusion-forging process to minimize the forging sequence. High-temperature properties of metallic, intermetallic, and nonmetallic materials are being determined to assess their utility as 2400°F forging dies. (auth)

6693 (NAA-SR-Memo-5887) JOINING TECHNIQUES APPLICABLE TO FUEL ELEMENT FABRICATION. E. F. Cook (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 15, 1960. 40p.

Several difficult joining problems were solved using welding techniques specifically developed for the application. Fuel cylinder end closure designs were evaluated, for use on a stainless steel clad NaK bonded tubular fuel element. Design changes were made, to eliminate microstress cracks in the cladding that resulted from high thermal gradients encountered in tungsten-arc machining welding. These changes resulted in the production of structurally sound end closures. A tungsten-arc spot-weld technique, for end closures of small diameter fuel tubes, was developed and evaluated. This technique was used to fabricate metallurgically-sound and vacuum-tight end closures on Type 304 stainless steel cladding. Joining techniques for the end closure of extruded APM alloy M257 cladding were investigated and evaluated. A tungsten-arc, fusion-welded end closure was developed. (auth)

6694 (NEPA-1425) PROGRESS IN THE DEVELOPMENT OF CERAMIC GLAZE COATINGS FOR BERYLLIUM CARBIDE UNDERBODIES. Murray A. Schwartz and W. J. O'Leary (Fairchild Engine and Airplane Corp. NEPA Div., Oak Ridge, Tenn.). Apr. 15, 1950. Decl. July 18, 1961. Contract [W-33-08-ac-14801(16250)]. 18p.

Experimental progress in development of techniques for producing uniform, thin, vitrified ceramic coatings on beryllium carbide-rich reactor fuel rod shapes is discussed. The coatings described were formed on the surface of the compacts by firing the pieces in various furnaces subsequent to their being sprayed with slips containing fritted oxides. Three different furnaces, a graphite tube resistor type, a molybdenum wire resistance type, and a molybdenum tube inductor type, were utilized. This was done to find a potentially satisfactory firing method. The graphite resistor furnace was found to be unsatisfactory for firing the ceramic type of coating, due to the fact that the furnace atmosphere is strongly reducing. A glassy coating could be developed in the molybdenum resistance furnace; however, the coating could not be fully matured. Final maturing of the glass-type coating developed in the molybdenum resistance furnace was satisfactorily accomplished by placing the coated specimen in the molybdenum induction furnace. (auth)

6695 (NEPA-1622) PROTECTIVE COATINGS FOR BERYLLIUM CARBIDE-MATRIX FUEL-ELEMENT BODIES. PART III. H. F. Reid, L. S. O'Bannon, and C. G. Harman (Battelle Memorial Inst., Columbus, Ohio). Oct. 17, 1950. For Fairchild Engine and Airplane Corp. NEPA Div., Oak Ridge, Tenn. Contract [W-33-08-ac-14801(16250)]. 27p. (BMI-N-51).

More than 100 coatings were developed which protected a beryllium carbide-matrix underbody containing 2.5% of uranium carbide against oxidation during exposure in a normal atmosphere at 2500°F for >400 hr and deterioration during exposure in moist air at 2500°F for 24 hr. Approximately 50 other coatings were tested which performed satisfactorily in a normal atmosphere; these coatings, however, did not protect the underbody adequately under moist conditions. Metallographic examinations of coated specimens after exposure in air at 2500°F indicated that the coatings acted somewhat as a filter in restricting the flow of air to the surface of the underbody. A beryllium oxide interfacial layer between the underbody and coating was found which often contained foreign inclusions or unidentified phases. (D.L.C.)

6696 (NP-11199) MECHANICAL AND METALLURGICAL BEHAVIOR OF SHEET MATERIALS. PROCEEDINGS OF THE SEVENTH SAGAMORE ORDNANCE MATERIALS RESEARCH CONFERENCE CONDUCTED AT SAGAMORE CONFERENCE CENTER, RACQUETTE LAKE, NEW YORK, AUGUST 16 TO 19, 1960. (Syracuse Univ., N. Y. Research Inst.). Contract DA-30-069-ORD-2566. 936p. (Met E 661-611/F).

Papers presented at the Seventh Sagamore Ordnance Materials Research Conference are given. The 40 papers are grouped under the following topics: requirements of high-strength sheet materials; materials properties and characteristics; effects of fabrication variables; fracture, crack initiation and propagation; mechanical screening tests; and mechanical model testing. (M.C.G.)

6697 (NP-11227) INVESTIGATION TOWARD OBTAINING SIGNIFICANTLY HIGHER MECHANICAL PROPERTIES OF AS-WELDED JOINTS IN HIGH-STRENGTH, HEAT TREATABLE ALUMINUM ALLOYS. Report No. 2-61-44. Fred R. Collins (Aluminum Co. of America. Alcoa Research Labs., New Kensington, Penna.). Sept. 6, 1961. Contract DA-36-034-ORD-3237 RD. 50p.

Welding techniques, filler metal-parent metal selection, and moderate temperature post-weld thermal treatments are described which were employed to achieve tensile strengths up to 72,000 pounds per square inch (psi) in welded heat treatable aluminum alloy sheet. The

aluminum–zinc–magnesium–copper (Al–Zn–Mg–Cu) alloys 7075 and 7178 welded Al–Mg or Al–Mg–Zn filler metals gave higher as-welded strengths than the Al–Cu alloys 2219 and 2014. Although more susceptible to weld cracking than the Al–Cu alloys, 7075 and 7178 showed excellent response to post-weld aging when welded in either -W or -T6 tempers. A filler metal Al-4 Mg-2 Zn, gave welds almost as strong as parent filler metal with less cracking. Tensile strengths of 70 to 72,000 psi were achieved in $\frac{1}{8}$-in. 7178-T6 sheet welded with Al–Mg–Zn filler metal and post weld aged eight hours at 212°F plus three hours at 325°F. Strength in the bulge test was about 60,000 psi. Welds in 7075-T6 attained about 68,000 psi tensile strength when post-weld aged 168 hrs at 212°F. Both tensile and bulge strengths were about 15,000 psi higher for post-weld aged than for as-welded joints. Direct current, straight polarity tungsten inert gas welding with helium gave the most consistently high strengths. Consumable electrode, spray transfer welding was next best. Short-arc consumable electrode welding gave highest individual weld strengths, but consistency was poor. (auth)

6698 (WAPD-251) IRON, CARBON, AND NITROGEN IMPURITIES IN PWR-2 SEED FUEL. J. Belle, L. Berrin, J. C. Clayton, I. Cohen, J. M. Markowitz, and T. R. Padden (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Dec. 1961. Contract AT-11-1-GEN-14. 49p.

Observation of a localized exaggerated swelling in irradiated ZrO_2–46 wt % UO_2 seed fuel wafers accompanied by a white spot inclusion phase and the detection of nitrogen in punctured compartments of irradiated fuel elements led to a re-examination of impurity specifications for the sintered wafers. The white spot inclusions observed in unirradiated seed materials are caused by the introduction of iron as a contaminant. Appropriate modifications in the process for fabricating seed fuel are shown to lead to low iron, carbon, and nitrogen impurity concentrations. (auth)

6699 (WAPD-TM-290) BEHAVIOR OF HIGHLY RESTRAINED PARTIAL PENETRATION WELDS IN AUSTENITIC STAINLESS STEEL. P. N. Seran (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Dec. 1961. Contract AT-11-1-GEN-14. 13p.

Transgranular cracking was found in austenitic stainless steel partial penetration weld joints in an autoclave head. The joint design was revised to reduce the stress at the weld root and to eliminate the corrosive media. It is recommended that the use of any partial penetration welds be limited to the maximum extent possible and, if used, should be welded with the inert gas shielded metal arc process for the root layer. (auth)

6700 ON THE ROLLING AND RECRYSTALLIZATION TEXTURES OF ZIRCONIUM. Henri Demars and Pierre Lehr. Compt. rend., 253: 2688-90(Dec. 4, 1961). (In French)

A sheet of Zr is rolled to 1.5% of its original thickness at room temperature. The rolling texture is found to be as follows: poles of the type (0002) are at ±32° to the rolling plane; and the $\langle 1010 \rangle$ directions are parallel to the rolling direction. After annealing for one hour at 800°C in vacuum, the recrystallization texture is as follows: poles of the type (0002) are at ±32° to the rolling plane; and the $\langle 1120 \rangle$ directions are parallel to the rolling direction. It is concluded that the recrystallization corresponds geometrically to a rotation of 30° about the [0001] axis. (T.F.H.)

6701 WELDING OF ZIRCONIUM AND ITS ALLOYS UNDER CONDITIONED ATMOSPHERE. R. Besse (Commissariat à l'Énergie Atomique, [Paris]) and M. Pages. Énergie nucléaire, 3: 319-27(Sept.-Oct. 1961). (In French)

A method which permits the welding of zirconium and its alloys on an industrial scale is given. As zirconium is a very oxydizable metal, the principle of this method is that of welding in a sealed container under an atmosphere of purified argon. A detailed description of the container is given. The suitability of the method is proved by tests on Zircaloy-2 samples, in particular traction and microhardness tests. (tr-auth)

6702 PREPARATION OF THIN METAL FOILS FROM ALKALI AND ALKALI EARTH METALS. A. D. Bondar, V. N. Karev, and A. P. Klyucharev (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Pribory i Tekh. Ekspt., 6: No. 4, 136-9(July-Aug. 1961). (In Russian)

Two methods for preparing thin foil targets of alkali and alkaline earth metals are described: the method of azide disintegration and the method of thermal reduction of oxides by metallic lanthanum in vacuum. Prepared calcium foils were irradiated with 5.4 and 6.8 Mev protons at currents of 10^{-9} to 10^{-10} amp. (R.V.J.)

6703 PREPARATION OF FREE FILMS BY VACUUM EVAPORATION METHOD. Yu. A. Bin'kovskii, O. F. Nemets, and V. A. Stepanenko (Inst. of Physics, Academy of Sciences, Ukrainian SSR). Pribory i Tekh. Ekspt., 6: No. 5, 190(Sept.-Oct. 1961). (In Russian)

The preparation of free-film targets by cold-surface evaporation, by precipitation on heated surfaces, and by using enriched isotopes is described. (R.V.J.)

6704 DIFFUSION BONDING HIGH-TEMPERATURE ALLOYS WITH BERYLLIUM. BERYLLIUM-TRANSPORT ALLOY STRIPS PRODUCE DIFFUSION-BONDED JOINTS IN $\frac{1}{2}$ TO 5 MIN AT 1940 TO 2100°F BONDING TEMPERATURES. W. Feduska and W. L. Horigan (Westinghouse Electric Corp., East Pittsburgh, Penna.). Welding J. (N. Y.), 41: 28s-35s(Jan. 1962).

The concepts and advantages of diffusion bonding high-temperature alloys with beryllium are discussed, and a practical method for diffusion bonding is presented. Results show that beryllium is a useful primary diffuser element for diffusion-bonding iron, nickel, and cobalt-base high temperature alloys. Beryllium-transport alloys are also developed that facilitate preplacement of beryllium at interfaces between base metals to be joined. These alloys contain beryllium in solid solution at bonding temperature, and they produce diffusion-bonded joints rapidly from $\frac{1}{2}$ to 5 min at bonding temperatures of 1940 to 2100°F. Only intimate contact is needed between the beryllium-transport alloys and the base metal members. The alloys can be easily rolled into strip stock and can be formed into complex shapes to facilitate preplacement in joints. The shear strengths of the diffusion-bonded joints qualitatively correlate with the base metal ultimate strengths and yield strengths at 1500°F. (N.W.R.)

Properties and Structure

Refer also to abstracts 6543, 6807, and 6812

6705 (AD-261006) EVALUATION OF COATINGS FOR MOLYBDENUM. Final Report, June 15, 1961. Charles Wilks and Harry Magalotti (Martin Co., Baltimore). Contract NOw60-0321c. 76p. (ER-11462-6)

Four oxidation-resistant coatings for molybdenum were evaluated for the effects of temperature, pressure, and strain on coating life. Test conditions relevant to re-entry vehicle environments were utilized so that performance data might be useful in establishing design criteria. Temperature is the dominant factor influencing time-to-coating

failure. Pressure has no discernible effect on coating failure per se; it will affect the rate of oxidation of the exposed base material after coating failure. Strain levels below those which crack the coating have no measurable effect on coating performance. Strains sufficient to crack the coating completely produce immediate failure. All coatings, although brittle at room temperature, exhibit measurable ductility above 1600°F but tolerable levels, dependent on temperature, range from less than 0.5 to 8 to 10%. Strain tolerance below 1600°F was not evaluated. Diffusion is the basic controlling mechanism where excessive strain is avoided but may be accelerated at restricted local sites in the presence of incipient cracks, fissures, and other coating defects so that the basic potential of the coating is seldom fully realized. (auth)

6706 (ARF-2227-3) HIGH-TEMPERATURE OXIDATION PROTECTIVE COATINGS FOR VANADIUM-BASE ALLOYS. Bimonthly Report No. 3, October 12, 1961 to December 11, 1961. F. C. Holtz (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Jan. 8, 1962. Contract NOw 61-0806-c. 17p.

Oxidation-protective coatings for vanadium alloys were investigated for use at 2000°F and above. Coatings of flame-sprayed nickel on V–1 Ti–60 Cb afforded protection for over 60 hours at 2000°F without evidence of failure, and initial oxidation tests at 2200°F also indicated promise. A glassy phase is formed on the outer surface after relatively short exposure to air, and the self-healing capabilities of this phase are being investigated. Pack-cementation siliconized coatings applied under argon at 2200°F, using NaF as an activator, were protective on V–1 Ti–60 Cb for 500 hours at 2000°F and 283 hours at 2200°F without failure. Initial tests of the siliconized coating on V–5 Ti–20 Cb show no signs of failure after 30 hours at 2000° and 2200°F. (auth)

6707 (ARF-2231-1) PILOT EVALUATION OF VANADIUM ALLOYS. Bimonthly Report No. 1, September 18, 1961–November 17, 1961. B. R. Rajala and F. C. Holtz (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Dec. 11, 1961. Contract NOw 62-0101-c. 10p.

Vanadium-base alloys under consideration for large-scale fabrication and evaluation exhibit marked elevated-temperature property changes with small variations in carbon, oxygen, and/or nitrogen levels. Increased amounts of interstitials cause reduced fabricability and higher elevated-temperature strength. Prior to the selection of candidates for pilot evaluation, the optimum levels of interstitials and the extent to which these elements are picked up (or lost) during processing are being determined. Analyses of V–5 wt % Ti–20 wt % Nb sheet stock produced by several methods indicate that an average of 0.031 wt % carbon and 0.034 wt % oxygen was picked up during melting and fabricating. (auth)

6708 (ASD-TR-61-459) LUBRICATION BEHAVIOR OF LIQUID METALS. P. H. McDonald and J. P. Lamb (North Carolina State Coll., Raleigh). Oct. 1961. Contract AF33(616)-5885. 19p.

Recent progress in the preliminary testing of experimental equipment for investigating the hydrodynamic and boundary lubrication behavior of liquid metals is surveyed. Results of the first boundary lubrication tests are presented and briefly discussed. (auth)

6709 (DC-58-5-76) RESULTS OF STRUCTURAL TESTS PERFORMED ON P-102 INNER PRESSURE VESSEL (DRAWING NO. 134R604). E. Ratterman (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). May 8, 1958. Contract AT(11-1)-171. 133p.

The structural integrity of the P-102 thin walled, Inconel-X pressure vessel was investigated by subjecting the vessel to three separate loading conditions. The vessel was instrumented with bonded wire resistance strain gages and with dial indicators during the tests. The internal hydrostatic pressure loading imposes, by far, the highest stresses on the vessel structure. (auth)

6710 (DC-58-6-150) EFFECT OF VARIOUS LOADS ON "INCONEL X" PRE-STRESSED COILED SPRINGS AT 1000°F. Thermodynamics and Mechanics Development Report No. 391. S. E. Eckard (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). June 4, 1958. Contract AT(11-1)-171. 37p.

Curves and tables are presented which show the effect of various loads on Inconel X coiled springs at 1000°F. A comparison is made between springs which are pre-stressed and which are not pre-stressed. In 100 hours, relaxation is less in springs which have been pre-stressed. A curve is presented which shows the decrease in spring rate with temperature. (auth)

6711 (DC-59-6-244) CERAMIC CORE TIE ROD: THERMAL INSULATION EVALUATION. S. E. Eckard (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). June 19, 1959. Contract AT(11-1)-171. 20p.

Various types of thermal barriers for small diameter metallic tubes to be used in nuclear reactor cores are compared. (auth)

6712 (DMIC-Memo-142) EFFECTS OF MODERATELY HIGH STRAIN RATES ON THE TENSILE PROPERTIES OF METALS. D. P. Moon and J. E. Campbell (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Dec. 18, 1961. 34p.

Data are plotted to show typical effects of increasing the strain rate to nearly 100 in./in.-min at room and elevated temperatures on the tensile properties of a number of commercial alloys. The alloys covered include Al alloys, Be, steels, stainless steels, superalloys, and Ti alloys. The trends illustrated by the graphs are summarized. A bibliography of 75 references is included. (D.L.C.)

6713 (MLM-1124) LOW TEMPERATURE RESEARCH ON POLONIUM-210. E. W. Wiederhold, J. W. Snider, and R. J. Spry (Mound Lab., Miamisburg, Ohio). May 30, 1960. Contract AT-33-1-GEN-53. 11p.

An investigation to determine the superconductivity transitions of polonium-210, indium bismuthide, and indium phosphide was made. No evidence of superconductivity was found down to 1.5°K in either polonium-210 or indium phosphide; the superconducting transition of indium bismuthide was found to agree with the literature values. (auth)

6714 (NEPA-721) REPORT ON BERYLLIUM. Walter Baxter (Fairchild Engine and Airplane Corp. NEPA Div., Oak Ridge, Tenn.). Aug. 20, 1948. Contract [W-33-08-ac-14801(16250)]. 121p.

The properties, fabrication, preparation, and analysis of beryllium are described. Data are presented on chemical composition, density, specific gravity, isotopes, abundance of element and availability, melting point, softening range, boiling point, vapor pressure, specific heat, coefficient of expansion, thermal conductivity, dielectric loss, electrical resistivity, emissivity, modulus of elasticity, modulus of rupture, Poissons ratio, hardness, thermal shock resistance, mechanical resistance, flow characteristics under stress, strength at elevated temperatures,

stability with gaseous media, casting, forging, extrusion, welding, rolling, powder metallurgy, unusual fabrication methods, and toxic properties. Equilibrium studies with other elements and compounds, structural studies, and changes in properties under exposure to radiation are discussed. (M.C.G.)

6715 (NEPA-932) THE HEAT CAPACITY OF BERYLLIUM CARBIDE POWDER IN STAINLESS STEEL CAPSULES AS A FUNCTION OF TEMPERATURE (400°–1800°F). Helen Powers, Theodore Kostigen, and J. B. Trice (Fairchild Engine and Airplane Corp. NEPA Div., Oak Ridge, Tenn.). Apr. 20, 1949. Decl. July 18, 1961. Contract [W-33-08-ac-14801(162 50)]. 17p.

The mean heat capacity of a sample of powdered beryllium carbide, a possible moderator material for a nuclear reactor, was determined as a function of temperature. A thin-walled stainless steel capsule containing the material was heated in an electric furnace and dropped into a water calorimeter. The following linear equation for mean heat capacity over the temperature range 50°C–T°C as a function of temperature, T, was derived from the data by the method of least squares: $C_p = 0.299 + 2.16 \times 10^{-4}\,T\,°C \pm 0.005$ cal $gm^{-1}(°C)^{-1}$. The numerical value of C_p expressed by this equation is also equal to the mean heat capacity in Btu $lb^{-1}(°F)^{-1}$. (auth)

6716 (NEPA-1221) PRELIMINARY INVESTIGATION OF THE SOLUBILITY OF METALLIC ELEMENTS IN BISMUTH. J. W. Johnson and D. S. Jesseman (Fairchild Engine and Airplane Corp. NEPA Div., Oak Ridge, Tenn.). Nov. 17, 1949. Contract [W-33-08-ac-14801(16250)]. 17p.

A preliminary investigation of the solubility of Cr, Nb, Fe, Mo, and Ni in liquid Bi at 900, 1350, and 1850°F for periods of 4, 24, and 100 hr was conducted. At 100 hr the temperature coefficient of solubility over the range studied for Cr was computed to be 0.05 ppm/°F, for Nb, 0.17 ppm/°F, for Fe, $6.2 \times 10^{-4}\,T - 0.18$ (T = °F) ppm/°F, for Mo, <0.001 ppm/°F, and for Ni, 7.1×10^{-3}%/°F. (auth)

6717 (NEPA-1316) LITERATURE SEARCH ON LEAD–BISMUTH ALLOYS. M. E. Lee (Fairchild Engine and Airplane Corp. NEPA Div., Oak Ridge, Tenn.). Feb. 14, 1950. Contract [W-33-08-ac-14801(16250)]. 11p.

The use of a lead-bismuth alloy as a coolant in the removal of heat from power-generating nuclear reactors was considered with the possibility that its ternary alloy with uranium or plutonium might be of use in a reactor of the circulating-liquid-fuel type. Information collected from the literature covering phase-equilibrium studies, physical-property data, and reactivity of this alloy toward other substances is presented. (auth)

6718 (NEPA-1465) PRELIMINARY INVESTIGATION OF METALLIC ELEMENTS IN MOLTEN LITHIUM. D. S. Jesseman, G. D. Roben, A. L. Grunewald, W. S. Fleshman, Kermit Anderson, and V. P. Calkins (Fairchild Engine and Airplane Corp. NEPA Div., Oak Ridge, Tenn.). June 8, 1950. Contract [W-33-08-ac-14801(16250)]. 14p.

The solubilities of beryllium, chromium, iron, molybdenum, nickel, niobium, silicon, tantalum, titanium, tungsten, vanadium, and zirconium, in molten lithium were investigated. Most of the data covered the temperature range between 482 and 1010°C (900 to 1850°F) for periods of 4, 24, and 100 hours. Nickel, silicon, and tungsten underwent complete degradation; beryllium, tantalum, and titanium were markedly soluble at 1010°C (1850°F); chromium, niobium, and zirconium showed a moderate increase in solubility with temperature; iron and vanadium showed negative solubility coefficients; molybdenum was only slightly soluble at 1010°C (1850°F). (auth)

6719 (NEPA-1482) PRELIMINARY HANDLING TESTS OF LIQUID BISMUTH. R. Potter, R. Wingard, and R. Boggild (Fairchild Engine and Airplane Corp. NEPA Div., Oak Ridge, Tenn.). June 2, 1950. Contract [W-33-08-ac-14801(16250)]. 29p.

A bismuth P-T rig was devised to gain some experience in handling liquid bismuth. In studies with pipes it was concluded that where permanent connections are feasible, welding should be employed. Otherwise, ring gasket flanges and ground joint unions proved satisfactory at temperatures as high as 1000°F. Straight screw threads with a soft metallic gasket are not recommended in contact with bismuth. An automotive type spark plug used as an insulated and sealed electrical probe failed immediately on contact with high pressure molten bismuth. Molten bismuth was repeatedly frozen in a pipe capsule in a deliberate attempt to burst the pipe. Some actual deformation was measured, but in no case did the pipe burst. Twenty-eight different types of insulating and fire brick materials were subjected to contact with molten bismuth to determine the extent of any resulting reaction. Asbestos millboard and Superex showed the greatest resistance, but in no case was there any very active reaction. (M.C.G.)

6720 (NEPA-1619) PROTECTIVE COATINGS FOR BERYLLIUM CARBIDE-MATRIX FUEL-ELEMENT BODIES. PART II. H. F. Reid, L. S. O'Bannon, and C. G. Harman (Battelle Memorial Inst., Columbus, Ohio). July 25, 1950. Decl. July 18, 1961. For Fairchild Engine and Airplane Corp. NEPA Div., Oak Ridge, Tenn. Contract [W-33-08-ac-14801(16250)]. 96p. (BMI-N-50)

More than 100 coatings were developed which protected uranium-bearing beryllium carbide matrix underbodies against decomposition in air at 2500°F for more than 400 hr. The coatings were found to increase slightly the resistance of the underbody to thermal shock, moisture, and erosion. Microscopic examination of coated specimens after oxidation testing showed the beryllium carbide matrix underbody to be encased in an interfacial film of beryllium oxide 0.002 to 0.004 in. thick. The efficiency of two coatings was not altered appreciably by increasing the uranium carbide content of the underbody from 2.5 to 10%. (D.L.C.)

6721 (NP-11206) DEFENSE METALS INFORMATION CENTER SELECTED ACCESSIONS. Virginia L. Frazier, comp. (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Dec. 1961. 73p.

A bibliography of 129 references on metals and related subjects with abstracts is divided into the following sections: high-strength alloys, light metals, nonmetallics, refractory metals, and miscellaneous (coatings, applications, and composites). Numerical, author, and subject indexes are included. (D.L.C.)

6722 (NP-11233) RESEARCH ON PHASE EQUILIBRIA BETWEEN BORON OXIDES AND REFRACTORY OXIDES, INCLUDING SILICON AND ALUMINUM OXIDES. Quarterly Progress Report No. 1, July 1, 1959–September 30, 1959. Wilfrid R. Foster (Ohio State Univ. Research Foundation, Columbus). Oct. 7, 1959. Contract AF33(616)-6509. 11p.

Development work on the preparation of pure B_2O_3 is described. Studies were made on compound formation between B_2O_3 and Al_2O_3; evidence was found for the compound $9Al_2O_3 \cdot 2B_2O_3$. No evidence was found for compound formation in the B_2O_3–SiO_2 system above 250°C. (D.L.C.)

6723 (ORNL-TM-24) THERMAL STRESSES IN HOLLOW CYLINDERS OF BERYLLIUM OXIDE. R. W. Swindeman (Oak Ridge National Lab., Tenn.). Jan. 9, 1962. Contract [W-7405-Eng-26]. 21p.

The problems of experimentally studying the effects of thermal stresses in beryllium oxide are considered in detail. Several ways of producing thermal stresses in hollow cylinders are described and the theoretical stress equations are given for these conditions. Theoretical treatment and practical considerations indicate that an experimental technique involving a static ΔT and external heating of a hollow cylinder should be the most acceptable experimental approach. (auth)

6724 (UCRL-9880) HEAT-CAPACITY STUDIES AT LIQUID HELIUM TEMPERATURES AND BELOW. PART I. THE ALKALI METALS. PART II. SMALL PARTICLES OF MAGNESIUM OXIDE (thesis). William Henry Lien (California. Univ., Berkeley. Lawrence Radiation Lab.). Jan. 1962. Contract W-7405-eng-48. 77p.

The heat capacity of sodium was measured from 0.15 to 1.5°K and that of potassium rubidium, and cesium from 0.15 to 4.0°K. Their heat capacities could be represented by $\gamma T + AT^3 + BT^5$ for $T < \theta/30$, where γT represents the contribution of the conduction electrons, and $AT^3 + BT^5$ represents the contribution of the lattice vibrations. For each metal, γ was compared with values given by various theories of the electronic structure of metals. Also for each metal, A and B were compared with the results of a lattice dynamic calculation. The heat capacity of two samples of magnesium oxide powder was measured from 1.5 through 4.0°K. One sample had a specific surface area of 166 m^2/g and the other, 13.1 m^2/g. The heat capacity of both samples could be represented by the sum of a T^2 and a T^3 term. The T^3 term is the usual volume-dependent term representing the total heat capacity in a macrocrystalline sample. The T^2 term is a surface-dependent term and appears only in samples with high surface-to-volume ratios. This term was compared with various theories of surface heat capacities for both samples. 53 references. (auth)

6725 (UCRL-9952) THE THERMODYNAMIC PROPERTIES OF THE ALKALI HALIDES. Leo Brewer (California. Univ., Berkeley. Dept. of Chemistry and California. Univ., Berkeley. Lawrence Radiation Lab.). Nov. 1961. Contract W-7405-eng-48. 10p.

The thermodynamic properties of the alkali halides are reviewed, presenting data supplementary to that of Brewer and Brackett, Chem. Rev. 61: 425-432(1961). (T.R.H.)

6726 (WADC-TR-58-476(Vol.III, Rev.)) THERMOPHYSICAL PROPERTIES OF SOLID MATERIALS. VOLUME III. CERAMICS. Alexander Goldsmith, Harry J. Hirschhorn, and Thomas E. Waterman (Illinois Inst. of Tech., Chicago. Armour Research Foundation). June 30, 1960. Contract AF33(616)-5212. 1165p. (AD-265597).

Thermophysical property data, and their variation with temperature, are presented for a great number of solid materials based on literature published during the period 1940-1957. Each reported value is shown and annotated, and recommended "most probable value" curves are given. Materials covered are ceramics, melting above 1000°F. Properties covered include the following: melting point, density, latent heats, specific heat, thermal conductivity, thermal diffusivity, emissivity, deflectivity, thermal expansion, vapor pressure, and electric resistivity. (auth)

6727 (AEC-tr-4933) ALUMINUM AND GAS. Hans Kostron. Translated for Oak Ridge National Lab., Tenn. from Z. Metallk., 43: 269-84(1952). 65p. (Includes original, 16p.).

A study was made of the aluminum–hydrogen system with special emphasis on the small amount of hydrogen which is normally absorbed by aluminum. The effects of atmosphere on aluminum were investigated. The equilibrium of aluminum and hydrogen systems above and below the melting point was determined. The state of the dissolved hydrogen, the effects of alloying elements on hydrogen absorption, adsorption, absorption of hydrogen from water vapor, diffusion of hydrogen in aluminum, and the effects of dissolved hydrogen on aluminum were studied. (M.C.G.)

6728 DETERMINATION OF CERTAIN PHYSICAL PROPERTIES OF SYNTHETIC GRAPHITE LAYERS. Z. R. Gorbis and V. A. Kalender'yan. Atomnaya Energ., 11: 450-4(Nov. 1961). (In Russian)

The potential use of moving graphite particles as a heat transfer medium is of great interest in nuclear technology; it also makes it necessary to obtain information on the physical and mechanical properties of the material. Tests were carried out with material obtained from the Zaporozhe and the Novocherkass electrode plants. The density of the powdered material was 2050 kg/m^3 while that of the fabricated graphite items was 1650 kg/m^3. The bulk weight of the powder was increased by decreasing the particle size; repeated circulation of the suspended powder through metal pipes resulted in such a reduction by wearing. The average particle size was reduced from 1.34 to 1.22 mm after circulating the powder for periods up to 700 hours. Data obtained pointed to a strong correlation between density and thermal conductivity and other physical properties of the material; e.g. a change of the specific gravity of the packed layer from 0.578 to 0.644 resulted in an increase of the effective coefficient of thermal conductivity at 400°C from 0.81 to 1.08 kcal/m.hr. No data are yet available on the changes of the physical properties of graphite layers exposed to reactor radiation but no great changes are anticipated. Data on solid graphite specimens indicate that the change in the thermal conductivity of the intragranular gas layers which are subject to ionization, may play a great role in this respect. (TTT)

6729 THERMAL ATTACK UNDER VACUUM (2×10^{-6} mm Hg) OF URANIUM IN α AND γ PHASES. Nicole Siménel and Daniel Calais (École des Mines, Paris). Compt. rend., 253: 1444-6(Oct. 2, 1961). (In French)

After heating electrolytically polished uranium under vacuum at 2 to 4×10^{-6} mm Hg, a thermal attack in the α and γ phases is observed. The comparison of the initial and final structures with that revealed by heating permits the evolution of uranium samples under thermal treatment to be followed satisfactorily. (tr-auth)

6730 STUDY CONCERNING THE RECRYSTALLIZATION OF ZONE-MELTED Al CONTAINING WEAK ADDITIONS OF Cu AND Mg. Colette Frois and Omourtague Dimitrov (Laboratoire de Vitry, C.N.R.S., France). Compt. rend., 253: 2532-4(Nov. 27, 1961). (In French)

The recrystallization rate of high-purity Al containing slight amounts of Cu or Mg as impurities is found to depend on the impurity concentration and the temperature. Below a certain critical concentration (2×10^{-4} at. % for Cu and 20×10^{-4} at. % for Mg) the recrystallization rate is essentially that for pure Al. A second recrystallization mechanism is observed at higher concentrations, which retards the recrystallization rate. This second mechanism has the same form for Cu and Mg, but the magnitudes of the effects are different. (T.F.H.)

6731 STUDY BY DIRECT ELECTRON MICROGRAPHY AND BY ELECTRON MICRODIFFRACTION OF THE ω PHASE OF Ti ALLOYS. Maurice Croutzeilles,

Paul Mirand, and Adrien Saulnier (Centre de Recherches Métallurgiques, Compagnie Pechiney, Chambéry, France). Compt. rend., 253: 2685-7(Dec. 4, 1961). (In French)

Electron micrography of the ω phase in Mo–W alloys is carried out by direct observation of electrolytically plated metallic preparations. The electron microdiffraction diagrams of the same preparations confirm the hexagonal structure of this phase, and give relations showing its orientation with respect to the solid solution. The general form of the precipitated particles is that of ellipsoids elongated along the $\langle 111 \rangle$ directions of the solid solution. (tr-auth)

6732 REACTIONS IN THE TERNARY SYSTEM ZIRCONIUM–TUNGSTEN–BORON. THE DOMAINS OF THE PHASES: COMPARISON OF RESULTS AND PREDICTIONS. André Chrétien and Jacques Helgorsky (Laboratoire de Chimie Minérale, Paris). Compt. rend., 253: 2693-5(Dec. 4, 1961). (In French)

The reactions of 1400°C in vacuum among Zr, B, and W, pelletized as mixtures under pressure, show the existence of 7 crystalline phases. Six of these (ZrB_2, W_2B, WB, W_2B_5, WB_4, and ZrW_2) are binary, and one may be ternary. The regions of coexistence of the various phases are determined. The product is always a mixture of at least 3 compounds (given an excess of B), and, at most, 5 compounds. The results are in agreement with thermodynamical predictions. (tr-auth)

6733 THE EFFECT OF THE MARTENSITIC TRANSFORMATION ON THE ELECTRICAL RESISTANCE OF LITHIUM AND DILUTE LITHIUM–MAGNESIUM ALLOYS. J. S. Dugdale (National Research Council, Ottawa) and D. Gugan. Cryogenics, 2: 103-14(Dec. 1961).

The resistivity of pure lithium at 80°K decreases by approximately 0.5% on transforming, and that of the alloys by a great deal more. By means of experiments using thermal cycling and mechanical deformation the intrinsic residual resistivities of the hcp and fcc phases of lithium and the magnesium–lithium alloys were found to be about 10 and 15% greater, respectively, than that of the bcc phase. The experiments show that there are large departures from Matthiesen's rule in all three phases of the alloys and in at least the bcc phase of quite pure lithium. These departures account for the much larger changes in resistance that are observed when the alloys transform than are observed when lithium transforms. (auth)

6734 THE PROBLEM OF STRENGTHENING SOLID SOLUTIONS OF NICKEL. L. I. Pryakhina and L. A. Ryabtsev (Baikov Inst. of Metallurgy, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 141: 406-8(Nov. 11, 1961). (In Russian)

Metals which are able to dissolve atoms of other elements in the solid state are usually strengthened by the distortion of their crystalline lattice, resulting in increased mechanical strength, electrical conductivity, etc. This question was experimentally studied by adding various elements to binary and multicomponent alloys of Ni. The elements studied included Cr, Ti, W, Mo, and Nb which form limited solid solutions with Ni, and Co which forms a continuous series of solid solutions. In the Al-bearing alloys the highest heat resistance was noted in compositions in which the increase of the Al concentration resulted in supersaturation of the solid solution and in precipitation of the γ' phase in the finely dispersed state. It was definitely established that addition of the new elements increases the heat resistance of the resulting alloy. X-ray diffraction studies revealed that such addition results in the increase of the lattice constants. In going from a 2-component to an 8-component system, the absolute value of the maxima of the heat resistance of the alloys increases in proportion to the number of the components, confirming previous observations. (TTT)

6735 OBSERVATIONS OF ETCH PITS AND DISLOCATION PATTERNS ON POLYCRYSTALLINE URANIUM. A. Bassi, S. Granata, and G. Imarisio (CISE, Segrate, Italy). Energia nucleare (Milan), 8: 744-50(Dec. 1961). (In English)

A method is described for obtaining etching patterns on α-uranium polycrystals. Such etching patterns are dislocations and hillocks. It is shown that the dislocations are generated during the casting of the sample and its subsequent phase transitions, while the formation of the hillocks can be related to the impurity content of the sample and their shape to its crystal structure. (auth)

6736 RARE EARTH SILICATES. VI. CONSTITUTION DIAGRAM OF Sm_2O_3–SiO_2 AND Yb_2O_3–SiO_2. N. A. Toropov and I. A. Bondar (Chemical Inst. of Silicates, Academy of Sciences, USSR). Izvest. Akad. Nauk S.S.S.R., Otdel. Khim. Nauk, No. 8, 1372-9(Aug. 1961). (In Russian)

Constitution diagrams were constructed for Sm_2O_3–SiO_2 and Yb_2O_3–SiO_2, and the properties of Sm and Yb silicates are compared to the silicates of other rare earths. The stratification region was found and the maximum composition with oxide (Ln_2O_3) was calculated. (R.V.J.)

6737 RECRYSTALLIZATION OF HIGH MELTING POINT METALS IN WELDING AND SOLDERING. N. V. Grevtsev and G. N. Klebanov. Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk Met. i Toplivo, No. 5, 62-9(1961). (In Russian)

The fast rate of heating in welding increases the temperature of recrystallization of Mo and W from 250 to 400°C and of Nb and Ta from 120 to 150°C and from 170 to 200°C. At fast heating rates the grain of Mo starts to enlarge at 1600°C. Recrystallization diagrams are plotted for Nb, Mo, Ta, and W at various temperatures and rates of heating. (R.V.J.)

6738 MECHANISM OF SURFACE GRAPHITIZATION IN DISINTEGRATION OF SOLID SOLUTIONS OF Ni–C AND Co–C SYSTEMS. V. N. L'nyanoi (Dnepropetrovsk State Univ., Ukrainian SSR). Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk Met. i Toplivo, No. 5, 70-2(1961). (In Russian)

Surface graphitization during the thermal treatment of saturated solid solutions of Ni–C(0.45C) and Co–C(0.55C) was studied at 350 to 650°. (R.V.J.)

6739 CREEP OF IODIDE ZIRCONIUM IN VACUUM UNDER CONSTANT PRESSURE. R. A. Osipov and A. L. Sotnichenko. Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk Met. i Toplivo, No. 5, 83-5(1961). (In Russian)

Studies were made of iodide zirconium creep under constant tension (10, 15, 20, 25, and 30 kg/mm^2) in vacuum at 18 to 500°C. The obtained activation energy of 14 kcal/g atom corresponds to a possible maximum energy shift which α–Zr crystals can withstand. (R.V.J.)

6740 STABILITY OF β-SOLID SOLUTION OF Ti–Fe–Cr ALLOYS. N. V. Ageev, O. G. Karpinskii, and L. A. Petrova. Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk Met. i Toplivo, No. 5, 86-9(1961). (In Russian)

The stability of β-solid solution Ti–Fe–Cr was studied in order to determine the effects of a third component on the stability of β-phase double systems. (R.V.J.)

6741 EFFECTS OF ALLOYING ON THE STRUCTURE AND PROPERTIES OF TUNGSTEN-COBALT CARBIDE. V. F. Funke, V. I. Tumanov, and Z. S. Trukhanova. Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk Met. i Toplivo, No. 5, 101-8(1961). (In Russian)

The bond of the carbide phase and the structure and properties of the WC–TiC–Co system were studied. The relation between WC–Co and WC–TiC–Co properties and cobalt content was found. Data are given on the distribution of alloying components (Cu, Mo, Cr, Al, and CrB) between phases in WC–Co. (R.V.J.)

6742 DIFFUSION OF OXYGEN IN ALPHA–TITANIUM. A. V. Revyakin. Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk Met. i Toplivo, No. 5, 113-16(1961). (In Russian)

The reaction of Ti with oxygen and the coefficient of oxygen diffusion in α–titanium were determined at 800 to 900°C. (R.V.J.)

6743 A PRESSURE-INDUCED PHASE TRANSFORMATION IN A UO_3 MONOHYDRATE. L. A. Harris and A. J. Taylor (Oak Ridge National Lab., Tenn.). J. Am. Ceram. Soc., 45: 25-8(Jan. 1962).

An orthorhombic dipyramidal form and an orthorhombic lath-shaped form of UO_3 monohydrate were grown hydrothermally. Optical and x-ray constants were determined for these crystalline modifications. The x-ray data corroborated previous data reported for the orthorhombic laths and for the dipyramidal form. An unreported phase transformation was observed to take place in the orthorhombic dipyramidal phase on the application of pressure. Optical and x-ray examinations of the new phase showed it to be identical to the orthorhombic lath phase. The transformation appeared to fit the "displacive transformation" classification. Optical observations made on partly transformed dipyramidal crystals lying on their (001) faces showed the two phases, the dipyramidal phase and the new phase, joined along a (11.l) dipyramid plane. The displacive movement appeared to have taken place in a $\langle 110 \rangle$ dipyramid direction. (auth)

6744 GRAIN GROWTH IN SINTERED URANIUM DIOXIDE. I. EQUIAXED GRAIN GROWTH. J. R. MacEwan (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Am. Ceram. Soc., 45: 37-41(Jan. 1962).

Grain growth was investigated in a UO_2 sinter of 94% theoretical density over the temperature range 1555 to 2440°C. The results were in close, but not exact, agreement with a theoretical expression describing grain growth with a polycrystalline matrix. For the material studied the mean grain diameter D(μm) after annealing for t hours at a temperature T(°K) was given by the equation $D^2 - D_0^2 = k_0 t^{0.8} \exp(-87{,}000/RT)$ where D_0 and k_0 are, respectively, the initial grain size and a proportionality constant. Uranium metal was found in all specimens annealed above 2000°C. This was taken as evidence that the UO_2 lattice can be oxygen-deficient at high temperatures. (auth)

6745 GRAIN GROWTH IN SINTERED URANIUM DIOXIDE. II. COLUMNAR GRAIN GROWTH. J. R. MacEwan and V. B. Lawson (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Am. Ceram. Soc., 45: 42-6(Jan. 1962).

Evidence is presented which shows that columnar grains can be induced to grow in high-density sintered uranium dioxide specimens by applying a steep temperature gradient at temperatures above 1700°C but below the melting point of 2800°C. Columnar growth apparently is a result of the migration of large transverse voids, whose individual widths define the cross sections of the grains, up a temperature gradient by a sublimation process. The grains grown by this process have a $\langle 111 \rangle$ preferred orientation along their columnar axis. A consequence of such void migration in operating fuel elements containing solid UO_2 pellets is the formation of a central void bounded by a region of oxide exhibiting columnar growth. (auth)

6746 THE CONSTITUTION OF SOME VANADIUM-BASE BINARY AND TERNARY SYSTEMS AND THE AGEING CHARACTERISTICS OF SELECTED TERNARY ALLOYS. S. Komjathy (Armour Research Foundation, Chicago). J. Less-Common Metals, 3: 468-88(Dec. 1961). (In English)

To promote development of vanadium-base alloys, binary (V–Sn, V–Hf, V–W, V–Re, V–Th) and ternary systems (V–Ti–Nb, V–Ti–Mo, V–Ti–Ta, V–Ti–W, V–Ti–Be, V–Ti–O, V–Ti–Si) were investigated to determine the extent of the vanadium-rich solid solution between 800 and 1500°C, the character of the second phase in equilibrium with the solid solution, and melt reactions. The age hardening of selected V–Ti–Be, V–Ti–O, and V–Ti–Si alloys was studied at 550, 650, and 750°C. (auth)

6747 THE DEVELOPMENT OF IMPROVED VANADIUM-BASE ALLOYS FOR USE AT TEMPERATURES UP TO 1800°F. B. R. Rajala and J. J. Van Thyne (Armour Research Foundation, Chicago). J. Less-Common Metals, 3: 489-500(Dec. 1961). (In English)

Vanadium-base sheet alloys containing titanium and/or niobium, molybdenum, tantalum, and tungsten exhibit excellent strength at elevated temperatures and weldability. Tensile and creep properties were determined in inert atmospheres. These alloys with outstanding cold fabricability are superior to the best nickel- and cobalt-base sheet materials on a density-corrected tensile strength basis at temperatures above 1500°F. (auth)

6748 A RECORDING EFFUSION BALANCE FOR PHASE DIAGRAM INVESTIGATIONS: U–Cd, U–Zn, AND Ce–Zn SYSTEMS. Ewald Veleckis, Charles L. Rosen, and Harold M. Feder (Argonne National Lab., Ill.). J. Phys. Chem., 65: 2127-31(Dec. 1961).

An apparatus for the determination of the volatility of one component of a system over a wide range of compositions is described. The apparatus, which couples a Knudsen effusion crucible with a recording balance, permits the investigator to make a rapid survey of phase boundary locations and, simultaneously, to observe the decomposition pressures of the phases involved. Three test systems were studied. The results corroborated, modified, or extended previously known phase diagrams. In the U–Cd system only the one (known) intermetallic compound, UCd_{11}, was found. Between 420 and 500° the U–Zn system study disclosed a single intermetallic phase, $UZn_{8.5-12}$. Only the end member of this solid solution range, $UZn_{8.5}$, was described previously. In the Ce–Zn system eight intermetallic phases were found: $CeZn_{11}$, Ce_2Zn_{17}, $CeZn_{\sim 7}$, $CeZn_{3.8-6.2}$, $CeZn_2$, CeZn, and Ce_4Zn. Of these eight phases, three were known, two were suspected, and three were indicated by indirect evidence. (auth)

6949 HALL EFFECT IN THE CARBIDES OF TRANSITION METALS. Takashi Tsuchida, Yoji Nakamura, Mamoru Mekata, Junji Sakurai, and Hideo Takai (Kyoto Univ.). J. Phys. Soc. Japan, 16: 2453-6(Dec. 1961). (In English)

Measurements were made of the electrical resistivity and the Hall constant of the carbides of the fourth and fifth group transition metals at room temperature in order to clarify the electronic structure of these compounds. The Hall coefficients are of the order of -10^{-3} coul^{-1} cm^3 for the fourth group carbides and of -10^{-4} coul^{-1} cm^3 for the fifth ones. Calculating the concentrations of the conduction electron on the basis of the one-band approximation, it was found that the conduction band may be almost empty for the fourth group carbides and may be occupied by about one electron per chemical formula unit for the fifth ones.

The results may suggest that all these carbides have band structures similar to each other. (auth)

6750 KINETIC AND GEOMETRIC CHARACTERISTICS OF THE MARTENSITIC TRANSFORMATION IN THE IRON–NICKEL–MANGANESE STEELS. M. E. Blanter and P. V. Novichkov (All-Union Machine Construction Inst., USSR). Metalloved. i Termichesk. Obrabotka Metal., No. 11, 12-19(Nov. 1961). (In Russian)

An Fe alloy containing 23.02% Ni and 3.35% Mn was used for studying the effect of temperature and the degree of transformation on the rate of the martensitic transformation process, and the dimensions of the martensite crystals formed. It was found that the temperature dependence of formation of crystals reaches a maximum; the absolute value of the rate of formation decreases with increasing transformation. The energy of activation of the crystals is independent of the above factors; it is equal to about 140 cal/g atom. The work of the formation of the crystals is independent of the degree of transformation and decreases only by a factor of 2 when the isothermal temperature is lowered from 4670 (–50°C) to 2360 cal/g atom (–155°C). A function describing the rate of the formation of the crystals is derived. The thickness, length and volume of the crystals are independent of the temperature, being a function of the degree of transformation. (TTT)

6751 THE QUESTION OF HARDENING AUSTENITIC STEELS. I. N. Bogachev (Ukrainian Polytechnic Inst., SSR). Metalloved i Termichesk. Obrabotka Metal., No. 11, 20-4(Nov. 1961). (In Russian)

Static and dynamic loading tests were used for studying the hardening of austenitic steels. The stable and unstable austenitic systems differ greatly in their ability to undergo deformation, and the hardening process takes place according to different mechanisms. Static deformation of Mn steels resulting from pressure by Brinell hardness testing balls is characterized by a greater increase of the hardness under the indentation and a more uneven distribution of this hardness than similar testing of Ni steels. The action of the introduction of C in increasing the resistance against plastic deformation is also stronger in the case of Mn steels. In these steels below 200°C the non-ferromagnetic ϵ-martensite is formed together with the α-modification. Dynamic loading produces a stronger hardening effect than static loading. Repeated sudden loading action of Mn steels results in a greater retardation of the hardening process than in Ni steels and saturation is reached at an earlier stage. Cavitation testing causes an increase of the fracture resistance of the metal by orders of magnitude. (TTT)

6752 THE EFFECT OF THE DEFORMATION TEMPERATURE ON THE MECHANICAL PROPERTIES OF AUSTENITIC STEELS. A. N. Chukhleb and V. P. Martynov (Aviation Inst., Kharkov). Metalloved. i Termichesk. Obrabotka Metal., No. 11, 44-7(Nov. 1961). (In Russian)

In several steels a complex relationship has been noted between the degree of deformation and the ability of the alloy to undergo martensitic transformation upon cooling. It was found that a slight amount of preliminary deformation of austenitic stainless steels enhances the martensitic transformation while a strong deformation results in the partial stabilization of the steel. This effect of the preliminary deformation on phase transformations during subsequent deformations at very low temperatures was studied for the purpose of establishing the optimal range to impart great hardness and plasticity to the metal. A magnetic device was used for detecting the $\gamma \rightarrow \alpha$ transformation. Tests were also carried out on the effect of multistage deformation processes, with deformations at room temperature, at –40 and at –183°C. The materials thus treated had high plasticity and satisfactory strength. It is thus possible to prepare a high-grade material by carefully choosing the conditions of deformation of 18-8 type steel; the metal can be worked subsequently by the usual means. (TTT)

6753 ANISOTROPIC DIFFUSION OF SILVER AND INDIUM TRACERS IN ZINC SINGLE CRYSTALS. Joseph H. Rosolowski (General Electric Research Lab., Schenectady, N. Y.). Phys. Rev., 124: 1828-32(Dec. 15, 1961).

The sectioning technique was used to measure the anisotropic diffusion of tracers in zinc single crystals. The diffusion of Ag^{110} was measured over the temperature range from 271 to 413°C. Referring the diffusion constants to the direction of the hexagonal symmetry axis of the zinc crystal structure, the results are: $D_{||} = (0.32 \pm 0.02) \exp [-(26.0 \pm 0.1) \times 10^3/RT]$ cm^2/sec, and $D_{\perp} = (0.45 \pm 0.07) \exp [-(27.6 \pm 0.2) \times 10^3/RT]$ cm^2/sec. The diffusion of In^{144} was measured over the range from 171 to 416°C. The results are: $D_{||} = (0.062 \pm 0.008) \exp [-(19.1 \pm 0.1) \times 10^3/RT]$ cm^2/sec, and $D_{\perp} = (0.14 \pm 0.02) \exp [-(19.6 \pm 0.1) \times 10^3/RT]$ cm^2/sec. These show that silver diffuses at a rate about one-tenth that of zinc self-diffusion while the indium diffuses at a rate about ten times as great. Also, $D_{||} > D_{\perp}$ for the silver diffusion as it is for zinc self-diffusion, while for the indium diffusion, $D_{\perp} > D_{||}$. These results are interpreted to indicate a vacancy mechanism of tracer migration with the possibility of a strong tracer-vacancy association occurring in the case of the indium. (auth)

6754 PECULIARITIES OF CONCRETE USED IN ATOMIC POWER PLANTS. Erhard Hampe. Silikat Tech., No. 12, 564-71(1960).

The screening effect of concrete against radioactivity and heat is largely dependent on its composition. Absorption of gamma rays due to the photoeffect, pair production, and Compton effect requires large and heavy atoms of the protective medium. Wall thickness may be low if the concrete density is sufficiently high. Absorption of neutrons is effected by elastic collision with light atoms of the radiation protection medium and subsequent capture of the slowed neutrons by atoms having a large neutron cross section. The neutron energy converted into gamma radiation must be absorbed as well. Therefore, concrete used for protection against neutron radiation must have components of low atomic weight, aggregates with a high water content, and a highly water-absorbent cement. For the purpose of protection against both neutron and gamma radiation, it is necessary to use concrete with heavy aggregates with a high content of crystal water (limonite and goethite), and highly water-absorbent cements, such as magnesium oxysulfate and magnesium oxychloride. The strength of concrete used for radiation protection must not be affected by absorption of heat and radiation. Heavy concrete may be produced by three processes: Application of the method used for normal concrete is difficult since, due to the heavy weight of the components, inhomogeneities frequently occur when mixing, transporting, and pouring the concrete into the planking. In addition, the heavy components have a pulverizing action in mixing and, thus, change the grain size; the wear and tear of the mixers is considerable, and shrinkage may occur as well. In the injection method, the aggregates which may have any weight, are poured into the planking, after which the mortar, prepared with heavy sand, is pressed in. (OTS)

6755 PYROGRAPHITE–A MATERIAL WITH ORIENTATED CRYSTAL STRUCTURE FOR USE IN RE-

ACTOR CONSTRUCTION. G. Solow. Silikat Tech., No. 12, 585-6(1960).

A material with marked anisotropic properties due to its laminated crystal structure is obtained by precipitating graphite from the gaseous phase onto a carrier which can be removed after having been used as a mold. Thermal and electric conductivity perpendicular to the lamination are 1000 times less than parallel to it. Pyrographite withstands the erosive effect of flowing gases at elevated temperatures, is gastight, and withstands even high temperatures. It is thus particularly suited for use in rocket engineering and electric cooling and heating processes. As its density is higher than that of ordinary graphite, it is better suited as a reactor moderator, especially because it offers a higher number of atoms per unit volume for slowing down neutrons. Contrary to ordinary graphite, pyrographite requires no additional purification because of its high purity. OTS)

6756 REACTION BETWEEN HEAT-RESISTING ALLOYS AND REFRACTORY OXIDES AT HIGH TEMPERATURES IN VACUUM. V. M. Amonenko, K. G. Romanchenko, and A. S. Tron' (Scientific-Research Inst. of Refractory Materials, Ukrainian SSR). Stal', 20: No. 11, 1002-4(1960).

In order to investigate the phenomenon of heat resisting alloys that contain elements which enter easily into reaction with the oxides of the refractory crucible and to establish the crucible composition that has least effect on the alloys, tests were undertaken with crucibles containing ZrO_2, BeO, MgO, Al_2O_3, and (Al_2O_3 + 1% TiO_2) and nickel-base heat-resisting alloys at various temperatures and with various holding times in vacuum. The tests were carried out in resistance furnaces having molybdenum heaters, the crucibles were made from chemically pure oxides, having a porosity between 0–2% and which were stabilized with 5% MgO or CaO. In the tests the effect of casting temperatures, duration of vacuum treatment, and crucible material on the gas content of the alloy were investigated. It was found that crucibles made from Al_2O_3, ZrO_2, MgO, and BeO entered into reaction with the C of the casting. Al, Zr, and Be reduced from the oxides were dissolved in the metal while carbon oxide and magnesium were eliminated in the gas-phase. The reduction process was accelerated at increased temperature. The minimum reduction rate was observed at 1450–1500°C and the minimum amount of reduction products were found in the alloy when the vacuum process no more than 20–30 minutes. The lowest oxygen content was found in alloys cast in ZrO_2 and BeO crucibles while the reduction process was the most intensive in MgO crucibles. When casting in Al_2O_3-containing crucibles, an exchange reaction took place between metal and refractory material, during which chrome and titanium were oxidized and Al_2O_3 was reduced to Al_2O, followed by its decomposition into Al_2O_3 and Al. Petrographically it was established that Cr_2O_3 was present in the refractory substance, indicating a reaction between the crucible and the chrome of the alloy. The tests on inclusions and the microscopic investigations showed spinelides of $Mg(Cr,Al)_2O_4$ in MgO crucibles, which were formed as a result of the reaction between the alloying elements and magnesium oxide. The higher the casting temperature, the longer the holding time of the metal, and the lower the remaining pressure in the chamber, the more complete was the elimination of N and H from the alloy. The refractory materials were arranged according to their degree of resistance against reaction with the alloy in the following series: MgO < Al_2O_3; (Al_2O_3 + 1% TiO_2) < BeO < ZrO_2. (OTS)

6757 THE DIFFUSION OF HOMOGENEOUSLY DISTRIBUTED RARE GASES FROM SOLID BODIES. Hj. Matzke and R. Lindner (Tekniska Hogskola, Goteborg). Z. Naturforsch., 16a: 845-9(Sept. 1961). (In German)

Methods for measuring the diffusion of rare gases from solids are critically discussed. New studies confirmed the finding that the diffusion of Xe^{133} in almost stoichiometrically composed UO_2 proceeds with an activation energy of about 50 kcal/mol. (tr-auth)

6758 PREPARATION AND PHYSICO-CHEMICAL PROPERTIES OF STRONTIUM HEXABORIDE. G. V. Samsonov, T. I. Serebryakova, and A. S. Bolgar (Inst. of Metal Ceramics and Special Alloys, Academy of Sciences, Ukrainian SSR). Zhur. Neorg. Khim., 6: 2243-8(Oct. 1961). (In Russian)

Strontium hexaboride (SrB_6) was produced by reducing strontium oxide with boron at 1800°C in vacuum. The approximate heat of formation of SrB_6 is 50.4 kcal/mole, the heat of sublimation is 97.2 ± 3.0 kcal/mole, the electric resistivity is 191.8 μohm · cm, the microhardness is 2900 ± 90 kg/mm^2, and the emission coefficient is 0.79. The equation of the vapor pressure for the temperature range 1400 to 2100°C was found to be $\lg p_{mm} = 6.43 - (21423/T)$. (R.V.J.)

6759 CONSTITUTION DIAGRAM OF Nb–Cu ALLOYS. I. A. Popov and N. V. Shiryaeva. Zhur. Neorg. Khim., 6: 2334-40(Oct. 1961). (In Russian)

Thermal, microstructure, and x-ray diffraction analyses were made of Nb–Cu alloys, and hardness and electric conductivity at various temperatures were determined. (R.V.J.)

6760 COMPOUNDS OF HAFNIUM WITH BERYLLIUM, CRYSTAL STRUCTURE AND SOME PROPERTIES. P. I. Kripyakevich, M. A. Tylkina, and E. M. Savitskii (L'vov State Univ. and Baikov Inst. of Metallurgy, Academy of Sciences, USSR.). Zhur. Strukt. Khim., 2: No. 4, 424-33 (July-Aug. 1961). (In Russian)

Microstructure, microhardness, and x-ray-diffraction analyses were made of prepared rf compounds with Be. The crystal structures were determined for four compounds. $HfBe_2$, $HfBe_5$, Hf_2Be_{17}, and $HfBe_{13}$. (R.V.J.)

6761 NUCLEAR GRAPHITE. OEEC Dragon Project Symposium, Bournemouth, November 1959. (European Nuclear Energy Agency, Paris). July 1961. 272p. (OEEC).

Twenty-five papers are included which treats such topics as Dragon Reactor design, development of low-permeability graphite, impregnation techniques, properties of impermeable graphite, and graphite joining methods. Separate abstracts were prepared for 24 of the papers; the remaining one was previously abstracted in NSA. (D.L.C.)

6762 THE DRAGON REACTOR EXPERIMENT. L. R. Shepherd. p.11-17 of "Nuclear Graphite." Paris, European Nuclear Energy Agency, 1961. (In English)

The problems involved in the design of a high-temperature gas-cooled reactor for the Dragon project are discussed in some detail. The coolant outlet temperature was set at 750°C. A semi-homogeneous reactor core was chosen comprising a mixture of graphite with fissile and fertile materials surrounded by inert graphite. The problems of fission product containment and/or scavenging and of CO and CO_2 impurities in the gaseous coolant are discussed. (D.L.C.)

6763 GENERAL DESIGN OF THE DRAGON REACTOR EXPERIMENT AND THE DRAGON FUEL ELEMENTS. G. E. Lockett. p.19-27 of "Nuclear Graphite."

Paris, European Nuclear Energy Agency, 1961. (In English)

Some of the requirements for the Dragon fuel elements are given. The core assembly and fuel rod desgins are described in detail. (D.L.C.)

6764 THE EARLY DEVELOPMENT OF GRAPHITE FOR DRAGON FUEL ELEMENTS. R. A. U. Huddle. p.29-31 of "Nuclear Graphite." Paris, European Nuclear Energy Agency, 1961. (In English)

A short history is given of the development of graphite for Dragon fuel elements from the materials point of view. It was found necessary to develop a graphite at least 10^5 times less permeable than standard nuclear graphite and in lengths of at least 6 ft. Furfuryl alcohol was successful as an impregnant, but problems were encountered in scaling-up the process. It is emphasized that the development work is in its very early stages, and the Dragon objectives are described. (D.L.C.)

6765 THE PROPERTIES OF EY9 ELECTROGRAPHITE AND ITS DERIVATIVES. A. R. Ford, R. K. Hurden, and P. K. C. Wiggs (Morgan Crucible Co., Ltd., London). p.35-42 of "Nuclear Graphite." Paris, European Nuclear Energy Agency, 1961. (In English)

The following properties are reviewed for EY9, EYX60, and EYX66 graphite grades: mechanical, structural (porosity and permeability), thermal, electrical, chemical, and impregnation. (D.L.C.)

6766 THE DEVELOPMENT OF LOW PERMEABILITY GRAPHITE. M. S. T. Price. p.43-50 of "Nuclear Graphite." Paris, European Nuclear Energy Agency, 1961. (In English)

The effects of binder content on extruded graphite are discussed. A low-permeability graphite, HX10, was developed from a mixture of low-permeability coarse grist particles and carbon black using conventional processing techniques. However, it was found necessary to bake under pressure in order to obtain maximum density. Data are given for the properties of HX10. (D.L.C.)

6767 CONTRIBUTIONS TO THE DEVELOPMENT OF FINE-GRAIN GRAPHITE OF LOW PERMEABILITY. E. Fitzer (Siemens-Planiawerke A. G. für Kohlefabrikate, Meitingen, Ger.) and K. W. F. Etzel. p.51-7 of "Nuclear Graphite." Paris, European Nuclear Energy Agency, 1961. (In English)

Extruded SIGRI brands of fine-grain reactor graphite are described. Sealing by impregnation and/or coatings is discussed. A method for determining permeability coefficients is described briefly. (D.L.C.)

6768 NEW QUALITIES OF IMPERVIOUS GRAPHITE. J. Parisot, G. Moutaud, E. Fourquin, and F. Tombrel (Société Le Carbone Lorraine, France). p.59-70 of "Nuclear Graphite." Paris, European Nuclear Energy Agency, 1961. (In English)

Permeability measurements are reported for various graphite grades. Characteristics of some fine-grained graphites are given. Bonding of graphite to metals and graphite is discussed briefly. The basis of two methods of permeability measurements is discussed. (D.L.C.)

6769 THE USE OF FURFURYL ALCOHOL AS A BONDING AGENT FOR LOW PERMEABILITY GRAPHITE. M. S. T. Price. p.71-81 of "Nuclear Graphite." Paris, European Nuclear Energy Agency, 1961. (In English)

The effects of multiple pitch impregnation on pore properties of reactor grade graphite show that fusible binders cannot be expected to produce low-permeability graphite. The requirements for an infusible binder are outlined, and a low-permeability graphite, HX12, was developed using an infusible resin derived from furfuryl alcohol as the bonding agent. HX12 is 10^4 to 10^5 times lower in permeability than reactor grade graphite and 10^2 times lower than HX10, and it can be made without pressure baking. An interim data sheet is given for the properties of HX12. (D.L.C.)

6770 SOME NOTES ON THE INDUSTRIAL PRODUCTION OF NUCLEAR GRAPHITE. P. Bergognon (Société Péchiney, Paris). p.83-7 of "Nuclear Graphite." Paris, European Nuclear Energy Agency, 1961. (In English)

Measurements of the density and capture cross sections of graphite produced for French reactors are reported. The average values are 1.702 g/cm^3 (density) and 3.68 mb (capture cross section for 1958). (D.L.C.)

6771 SOME EXPERIMENTS ON THE PYROLYTIC DEPOSITION OF CARBON ON CARBON FIBRES AND POWDERS. R. L. Bickerdike, G. Hughes, H. Ranson, D. Clark, and J. N. Eastabrook (Royal Aircraft Establishment, Farnborough, Hants, Eng.). p.91-100 of "Nuclear Graphite." Paris, European Nuclear Energy Agency, 1961. (In English)

Preliminary experiments were conducted on the pyrolytic deposition of carbon from nitrogen–benzene gas flows on shaped carbon fibers (carbonized cotton) and lamp black. In this way, a relatively dense coherent body can be built up. The properties of the treated articles were determined and their structure studied by metallography and diffraction methods. The results show that the structure of the deposit is largely independent of the substrate and that crystallite growth occurs on graphitization at 2800°C. (D.L.C.)

6772 LOW PERMEABILITY GRAPHITE: THE FURFURYL ALCOHOL PROCESS. W. Watt and W. Johnson (Royal Aircraft Establishment, Farnborough, Hants, Eng.). p.101-7 of "Nuclear Graphite." Paris, European Nuclear Energy Agency, 1961. (In English)

A process was outlined for impregnating EY9 grade graphite to give permeability reductions of several orders of magnitude, and some results are given. (D.L.C.)

6773 THE GAS IMPREGNATION OF EY9 GRAPHITE. R. L. Bickerdike and A. R. G. Brown (Royal Aircraft Establishment, Farnborough, Hants, Eng.). p.109-28 of "Nuclear Graphite." Paris, European Nuclear Energy Agency, 1961. (In English)

The reaction rate of carbon deposition from hydrocarbon gases on graphite pores is discussed. A large number of experiments were performed using benzene vapor in vacuum and benzene–nitrogen mixtures with stacked EY9 graphite discs to study the effect of temperature and benzene partial pressure on the penetration depth. The results show that for maximum penetration with benzene, temperatures near 750°C should be used. The effects of the deposition variables on the permeability of the graphite were also investigated. Preliminary deposition experiments were performed with ethylene, methane, and carbon tetrachloride. (D.L.C.)

6774 IMPERMEABLE GRAPHITE BY COMBINATION OF FURFURYL ALCOHOL AND GAS IMPREGNATION PROCESSES. R. L. Bickerdike and W. Watt (Royal Aircraft Establishment, Farnborough, Hants, Eng.). p.129-33 of "Nuclear Graphite." Paris, European Nuclear Energy Agency, 1961. (In English)

Both the gas and liquid (furfuryl alcohol) impregnation processes have disadvantages, the former leading to thin, impermeable layers concentrated at the surface and the

latter entailing the danger of specimen rupture by gas pressure. Two methods combining gas and liquid impregnations to reduce some of the disadvantages are outlined along with a method for making composite tubes. The effects of turning off treatment on the permeability are given. (D.L.C.)

6775 THE DEVELOPMENT AND PRODUCTION OF IMPERMEABLE GRAPHITE FOR THE HIGH-TEMPERATURE, GAS-COOLED REACTOR. L. W. Graham, J. G. Campbell, and D. R. Perels (Hawker Siddeley Nuclear Power Co., Ltd., Langley, Bucks, Eng.). p.135-47 of "Nuclear Graphite." Paris, European Nuclear Energy Agency, 1961. (In English)

Work carried out on the possibility of scaling up the furfuryl alcohol impregnation process is described. Difficulties in producing large quantities of fuel rods for the High-Temperature, Gas-Cooled Reactor Experiment are discussed. (D.L.C.)

6776 GASEOUS FLOW THROUGH GRAPHITE AND ITS RELATION TO THE HIGH-TEMPERATURE REACTOR SYSTEM. P. Barr (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.151-88 of "Nuclear Graphite." Paris, European Nuclear Energy Agency, 1961. (In English)

The measurement of gas flow characteristics of impregnated EY9 graphite is treated. An analytical introduction to the permeability coefficient is presented. The relationship of transient gas flow conditions to diffusion and permeability measurements is discussed. Measurement of permeability coefficients and distributions in impregnated graphite is treated in detail. (D.L.C.)

6777 MEASUREMENT OF GAS FLOW THROUGH GRAPHITE. Hans B. von der Decken (A. G. Brown-Boveri/Krupp, Mannheim, Ger.). p.189-97 of "Nuclear Graphite." Paris, European Nuclear Energy Agency, 1961. (In English)

The principles and performance of some methods used to measure gas flow through graphite are discussed. Diffusion, viscous flow, slip flow, and molecular flow are considered. Devices for measuring diffusion in graphite tubes and spheres are described, and preliminary results are presented. (D.L.C.)

6778 GASEOUS FISSION PRODUCT LEAKAGE. Frank Sterry (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.199-202 of "Nuclear Graphite." Paris, European Nuclear Energy Agency, 1961. (In English)

Gas permeability as the mechanism of volatile fission product escape is discussed with respect to the need for fission product containment in graphite for the Dragon project. Molecular and viscous flows are considered; data are presented which indicate that considerable viscous flow can exist even for low permeabilities. Transit times and escape mechanisms other than gas flow are briefly considered. (D.L.C.)

6779 ON THE TRANSMISSION OF FISSION PRODUCTS THROUGH IMPERMEABLE GRAPHITE. H. W. Schmidt and R. Schulten. p.203-8 of "Nuclear Graphite." Paris, European Nuclear Energy Agency, 1961. (In English)

Attempts are made to derive relations between permeability and fission product retention for two models, one with a number of parallel channels of equal length and the other with a number of different pockets connected with small pores. Molecular flow under steady-state conditions is assumed. Both models lead to the same type of function which represents the effect of fission product decay on the flow in terms of u/sinh u, where $u = l\sqrt{\lambda/k^*}$. (D.L.C.)

6780 IMPERMEABLE GRAPHITE BY THE CELLULOSE PROCESS. H. W. Davidson (General Electric Co., Ltd., Wembley, Middx, Eng.). p.209-11 of "Nuclear Graphite." Paris, European Nuclear Energy Agency, 1961. (In English)

A process which is now in the laboratory pilot plant stage is outlined for making impermeable graphite tubes from cellulose. The cellulose is made into a fine aqueous suspension and then slip-cast centrifugally to give tubular shapes. The shapes are dried, machined, baked to 1000°C, and graphitized above 2000°C. The process results in a very close pore structure. Preliminary estimates are made of the product's strength, corrosion resistance, and irradiation resistance. (D.L.C.)

6781 MECHANICAL AND PHYSICAL PROPERTIES OF EY9 GRAPHITE (INTERIM REPORT). N. W. D. Chrimes (Hawker Siddeley Nuclear Power Co., Ltd., Langley, Bucks, Eng.). p.213-16 of "Nuclear Graphite." Paris, European Nuclear Energy Agency, 1961. (In English)

Data are tabulated for the flexural stress, elastic modulus, compression strength, and electrical resistivity of solid and tubular EY9 graphite specimens in the untreated condition and after one and two impregnations by the furfuryl alcohol process, respectively. The effect of two impregnations can be summarized as follows: (1) flexural stress and elastic modulus are increased up to 60 to 70%; (2) ultimate compressive stresses are increased up to 200%; and (3) electrical resistivity is decreased up to ~20%. No evidence was found for a size effect, but a large amount of scatter is present in the data. (D.L.C.)

6782 THE BEND STRENGTH AND YOUNG'S MODULUS OF IMPREGNATED GRAPHITE. A. R. G. Brown and H. J. Brant (Royal Aircraft Establishment, Farnborough, Hants, Eng.). p.217-26 of "Nuclear Graphite." Paris, European Nuclear Energy Agency, 1961. (In English)

Preliminary results are given for the effects of the furfuryl alcohol and gas impregnation processes on the bend strength and Young's modulus of EY9 graphite. Comparison is made between the two impregnation processes. (D.L.C.)

6783 OXIDATION OF IMPREGNATED GRAPHITE. W. Watt and A. R. G. Brown (Royal Aircraft Establishment, Farnborough, Hants, Eng.). p.237-47 of "Nuclear Graphite." Paris, European Nuclear Energy Agency, 1961. (In English)

Measurements of the oxidation rates in air at 550°C are reported for EY9 graphite impregnated by furfuryl alcohol and gas pyrolysis, respectively. The data show that the impregnation process alone results in oxidation rates higher than these of untreated EY9 but that heat treatment can be used to reduce the oxidation rates to values below these of untreated EY9. The use of phosphoric acid as the polymerizing agent in the impregnation also helps to reduce the oxidation rates. (D.L.C.)

6784 GRAPHITE JOINTS. W. Johnson (Royal Aircraft Establishment, Farnborough, Hants, Eng.). p.251-7 of "Nuclear Graphite." Paris, European Nuclear Energy Agency, 1961. (In English)

Several graphite-to-graphite joints were made on EY9 graphite rods using furfuryl alcohol resin and Cascote M558 resin as cements, and tensile tests were made. The results show that the joint strengths are nearly equal to the strength of EY9 graphite and that it may be preferable to use a minimum quantity of cement and a light curing load. Tube joints were also made and the effects of loading and pitch coke additions to the cement on the joint permeability

studied; the results indicate the mix of 1/3 coke with 2/3 resin to be the most promising cement. (D.L.C.)

6785 GRAPHITE BRAZING TECHNIQUES. F. Wade. p.259-65 of "Nuclear Graphite." Paris, European Nuclear Energy Agency, 1961. (In English)

The use of Ti-cored Cu/Ag eutectic at brazing temperatures of 950°C and of Ti and Zr brazing temperatures of 1800 to 1850°C to braze graphite to graphite and other materials, e.g., ceramics and metals, is discussed. General considerations to be taken into account in making a brazed joint between graphite and other materials are given. (D.L.C.)

Radiation Effects

Refer also to abstracts 6544, 6545, 6548, 6810, 6811, 6822, 6823, and 6824

6786 (HW-71500-A) THE H-3 IRRADIATION EXPERIMENT: IRRADIATION OF EGCR GRAPHITE. Interim Report No. 1. J. M. Davidson and J. W. Helm (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 16, 1961. Contract AT(45-1)-1350. 71p.

Irradiation experiments are being performed in the GETR to determine the long-term stability of EGCR graphite. The results of two experiments with a peak total exposure equivalent to 38,000 MWD/AT in the EGCR are available. This is approximately one half the expected lifetime exposure of the EGCR. The H-3-1 and H-3-2 capsules contained samples of EGCR graphite and reference CSF graphite. Both capsules were identical and were irradiated sequentially to increase the dose on the samples. Sixty per cent of the samples irradiated in the H-3-1 capsule were reirradiated in the H-3-2 capsule. The capsule design utilized the gamma heating of the GETR E-7 facility to achieve desired operating temperatures. The temperatures on inter- and intra-cycle irradiation were constant within 25°C. Samples were irradiated in a temperature range of 475 to 850°C. The graphite tested was obtained from a full-size cross section of an EGCR block. Irradiation results did not indicate differences in contraction of parallel samples chosen at several positions within the block. Contraction rates of the graphites tested were found to depend on the temperature of irradiation. Estimates of the contraction rates of parallel samples of EGCR graphite are 0.15% per 10^{21} nvt at 575°C and 0.19% per 10^{21} nvt at 475°C. Parallel samples contracted at a higher rate than the transverse samples. The observed length changes are presented as a function of exposure. (auth)

6787 (NP-11217) THE EFFECT OF NUCLEAR RADIATION ON THE PERFORMANCE OF IMAGE ORTHICON TELEVISION CAMERA TUBES. D. L. Schaefer (General Electric Co. Cathode Ray Tube Dept., Syracuse, N. Y.). [nd]. Contract DA 36-038-ORD-21167M. 6p.

Paper presented at Conference, AIEE 1961 Winter General Meeting.

The effects of radiation on the Image Orthicon, a television pickup tube containing among its functional elements a photoemissive cathode, a storage target, an electron multiplier, and a thermionic cathode were studied. The environmentalized Z-5358 image orthicon used in these experiments utilized a high sensitivity magnesium oxide target. Video pictures were satisfactorily obtained during continuous gamma, pulse gamma, and continuous neutron radiation. The tube performed satisfactorily after exposure to multiple burst from a reactor. The only detectable degradation of the tube was that associated with the browning of the glass envelope. (auth)

6788 (NP-11219) PERFORMANCE OF IRRADIATED AND CHEMICALLY TREATED JP-5 FUEL WITH INHIBITED RED FUMING NITRIC ACID. S. R. Matos and E. J. Johnson (Picatinny Arsenal. Liquid Rocket Propulsion Lab., Dover, N. J.). Aug. 1961. 28p. (DL-TR-1-61)

Gamma irradiated and NALCO 305 treated JP-5 were evaluated as rocket fuels with inhibited red fuming nitric acid in a 300-lb-thrust uncooled rocket engine operated at 320 psia chamber pressure. No significant difference in performance was noted between the two treated fuels and the untreated JP-5 when tested under similar conditions using specific impulse as the criterion of comparison. The irradiated JP-5 was treated by immersion in a cobalt 60 gamma pool to a total radiation level of 1500 roentgens obtained at a rate of 500 roentgens per hour. Testing was performed within the half-life period of the irradiated fuel. The chemical treatment consisted of adding 0.38 ml of NALCO 305 per gal of JP-5. Prior to testing, the mixture was agitated and allowed to stand for eight hr to be certain that the additive had dispersed all the unstable fuel particles. Irradiation and chemical additives as a treatment for jet fuels was for the purpose of reducing the particle size of unstable constituents, determined to be present in the fuel by the electron microscope, to improve combustion and burning rate properties of the fuel. (auth)

6789 (NP-11236) EFFECT OF NUCLEAR RADIATION ON MATERIALS AT CRYOGENIC TEMPERATURES. Quarterly Progress Report No. 5, July 1961 through September 1961. (Lockheed Nuclear Products, Marietta, Ga.). Contract NASw-114. 77p. (NR-132)

The testing of flat and round tensile and tensile notched specimens of Ti and Al alloys and stainless steel 304 for the correlation program was almost completed and experimental data are tabulated. Equipment being developed are described, e.g., tensile extensometer and compressometer. A two-dimensional stead-state temperature distribution was computed for the test loop. An analysis of the nuclear heating of the gamma shield was made. Progress is reported on the construction of the test loop and associated equipment. (D.L.C.)

6790 (TID-14395) AN INVESTIGATION OF THE ELECTRICAL AND OPTICAL PROPERTIES OF SEMICONDUCTORS AND INSULATORS WHICH HAVE BEEN IRRADIATED BY FAST NEUTRONS. FINAL REPORT (PART I) [ON] RADIATION EFFECTS IN SOLIDS. (Arizona State Univ., Tempe). Oct. 1961. Contract AT(11-1)-715. 22p.

An investigation is described to determine if x rays cause precipitation of metal ions in ionic crystals. Preliminary results of studies are presented for NaBr, NaF, CsI, CsBr, CaF_2, and BaF_2. In other work, plans and equipment design for investigating the Seebeck coefficient of rutile are discussed. Results of radiation effects tests on TiO_2 are included. (J.R.D.)

6791 (NP-tr-826) ON THE CHANGES IN CARBOXYL-SUBSTITUTED BUTADIENE-STYRENE RUBBERS AND THEIR MIXTURES WITH ε-CAPROLACTAM UNDER THE ACTION OF γ-RAYS. I. Mladenov, I. A. Tutorskii, and B. A. Dogadkin. Translated by B. C. L. Salman (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.) from p.293-300 of "Mezhdunarodnyi Simpozium po Makromolekulyarnoi Khimii, SSR, Moskva, 14-18 Iyunya 1960. Doklady i Avtoreferaty. Sektsiya III." 9p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 20219.

6792 THE EFFECT OF NUCLEAR RADIATION ON THE PROPERTIES OF CONSTRUCTION STEEL. III. THE EFFECTS ON THE DESIGN AND MANUFACTURE OF REACTOR PRESSURE VESSELS. P. H. J. Simonis. Atoomenergie, 3: 211-18(Oct. 1961). (In Dutch)

Experimental results on the modifications induced in the properties of steel by fast neutron irradiation are reviewed and summarized. (J.S.R.)

6793 VARIATIONS IN THE ELECTRON MOBILITY IN Ge, IRRADIATED AT LOW TEMPERATURES BY FAST NEUTRONS. Nguyen Van Dong, Lydie Koch, and Nguyen Dinh Tuong. Compt. rend., 253: 2487-9(Nov. 27, 1961). (In French)

Samples of n-type Ge are bombarded by fast neutrons at 77°K. A study of the electron mobility in the domain of weak integral flux makes possible the detection of the creation of high local concentrations of imperfections in the crystal lattice. (tr-auth)

6794 APPLICATION OF EXCITON SPECTROSCOPY TO THE STUDY OF THE DAMAGES IN SOLIDS CAUSED BY NUCLEAR RADIATIONS. Serge Nikitine, Michel Grosmann, and Jean-Bernard Grun (Faculté des Sciences, Strasbourg). Compt. rend., 253: 2505-7(Nov. 27, 1961). (In French)

It is shown that the effect of nuclear bombardment on the exciton spectrum of Cu_2O is analogous to that produced by an external electric field. Thus the bombardment probably produces charged defects, which give rise to an internal electric field. (tr-auth)

6795 POSTIRRADIATION EXAMINATIONS OF BERYLLIUM OXIDE. T. N. McVay, R. E. Thoma, H. Insley, H. A. Friedman, and C. F. Weaver (Oak Ridge National Lab., Tenn.). J. Am. Ceram. Soc., 45: 48-9 (Jan. 1962).

Lattice parameter measurements of BeO specimens irradiated by neutrons showed dimensional changes in the specimens. Petrographic examination of specimens irradiated at 1.0 to 2.8×10^{21} nvt fast neutron dosage and at 100 to 965°C revealed that the indices of refraction were substantially lower than those of normal unirradiated control specimens and were lowest for the specimens irradiated at low temperatures. The BeO specimens were also annealed at periods of 16 to 143 hours. However, prolonged annealing periods did not alter further properties measured after 16 hour heating periods. The data are tabulated. (P.C.H.)

6796 MEASUREMENT OF THE RADIATION RESISTANCE OF TRANSISTORS. K. Zander (Hahn-Meitner Institut für Kernforschung, Berlin). Nukleonik, 3: 292-5 (Dec. 1961). (In German)

To test the qualifications of various transistor types for use in places exposed to radiation (for example in or in the immediate vicinity of a reactor or accelerator), the variation of the static and dynamic characteristics of germanium and silicon transistors was measured during irradiation in the research reactor BER. In agreement with work by other authors, silicon transitors, an alloyed germanium high frequency transistor, and a diffusion-alloyed germanium transistor showed good resistance to the effects of nuclear radiation. (tr-auth)

6797 RADIATION-INDUCED RECOMBINATION AND TRAPPING CENTERS IN GERMANIUM. I. THE NATURE OF THE RECOMBINATION PROCESS. O. L. Curtis, Jr., and J. H. Crawford, Jr. (Oak Ridge National Lab., Tenn.). Phys. Rev., 124: 1731-40(Dec. 15, 1961).

Extensive measurements on irradiated germanium indicate that previous analyses of the recombination process are incorrect. A model which explains the observations in both n- and p-type material is presented. According to this model, the recombination level lies 0.36 ev above the valence band in gamma-irradiated n-type germanium. Presumably due to the extensive perturbation caused by neutron irradiation, the level lies slightly lower in neutron-irradiated material. Trapping levels which are not present in antimony-doped germanium occur in arsenic-doped material ~0.17 ev above the valence band. Other trapping levels are observed only in high-resistivity antimony-doped samples. It was not possible to determine the values of hole and electron capture cross sections associated with the recombination level; however, the ratio σ_p/σ_n was determined: Its value is ~1000. (auth)

6798 ANISOTROPY OF COLOR CENTERS IN CALCITE. W. F. Kolbe and A. Smakula (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 124: 1754-7(Dec. 15, 1961).

Two absorption bands at 350 and 290 mμ were observed in calcite colored by 3-Mev electrons (10^5 to 10^6 rads) at −190°C. Samples cut parallel to the c axis colored and measured with polarized light ($E_{\perp c}$ and $E_{\parallel c}$) showed that the band at 350 mμ is isotropic while that at 290 mμ is anisotropic. The former is correlated to trapped electrons and the latter to trapped holes. Both bands are stable at −190°C but decay simultaneously at room temperature, accompanied by strong luminescence with a peak at 590 mμ. (auth)

6799 RADIATION IONIZATION PROCESSES IN GERMANIUM AND SILICON CRYSTALS. V. S. Vavilov. Uspekhi Fiz. Nauk, 75: 263-76(Oct. 1961). (In Russian)

Interaction of electromagnetic radiation and of charged particles with crystals is accompanied by ionization, i. e., by the formation of strong current-carrying agents. Experiments carried out with Si single crystals confirmed theoretical assumptions on the effect of external electric fields on the photoionization process. Studies of this phenomenon in the basic optical absorption band of Si and Ge show that with sufficiently high photon energy increases, the quantum yield exceeds unity; at photon energies much higher than that of the forbidden band the quantum yield is proportional to the photon energy. Ionization experiments with x and γ-rays were limited to energy ranges in which the electron-positron pair formation may be neglected in comparison with the photoelectric effect and Compton scattering. In the case of ionization by passage of fast charged particles through matter the average energy of the electron-hole pair does not depend on the energy of the particle. The possibility of creating p-n transitions in semiconductors offers a convenient method for studying the direct conversion of radiative energy, such as light, β- and γ-particles into electric energy. Si and Ge counters have a better resolution than gaseous ones and it is anticipated that they will be widely used in the near future as detectors in the intermediate energy range. (TTT)

PHYSICS

General and Miscellaneous

Refer also to abstracts 6257 and 6549

6800 (ARL-48) A DISCUSSION OF THEORIES OF GRAIN-BOUNDARY DIFFUSION. C. C. Maneri and F. J. Milford (Battelle Memorial Inst., Columbus, Ohio). July 1961. Contract AF33(616)-6265. 38p.

The major theoretical efforts dealing with grain-boundary diffusion were reconsidered with a view to establishing their mathematical rigor and laying a firm foundation for further work. The details of Whipple's solution to the boundary value problem were reconstructed and are given. Fisher's approximate solution and its relationship to the exact solution were considered. A way of evaluating the accuracy of this approximation was outlined. The work of Borisov et al., was shown to be equivalent to that of Whipple. Finally, an outline is presented of computational problems directed toward improving understanding of the relationship of grain-boundary diffusion to the usual model and evaluating various approximations which are frequently used in the study of grain-boundary diffusion. (auth)

6801 (ARL-109) PERTURBATION THEORY FOR THE FOCK-DIRAC DENSITY MATRIX. Technical Note No. 61. Roy McWeeny (Uppsala Univ.). Mar. 15, 1961. Contract AF61(052)-351. 20p. (AD-261224)

A direct method is given for obtaining, to any order, the effect of a perturbation on the Fock-Dirac density matrix of an N-electron system. (auth)

6802 (KR-12) QUARTERLY PROGRESS REPORT, JULY–AUGUST–SEPTEMBER 1961 [ON KJELLER RESEARCH]. (Norway. Institutt for Atomenergi, Kjeller). Dec. 1961. 70p.

Work carried out in atomic research at Kjeller is described. The construction of the steel containment for the JEEP II reactor is under way. The design of the reactor and auxiliary system is progressing. The NORA reactor was operated with the reference fuel charge to test experimental techniques and to check equipment. A single-crystal neutron diffraction instrument was put into operation. Further investigations were carried out on iodic acids. The investigation of the sintering properties of UO_2 as well as the corrosion studies of different canning materials proceeded. The performance of the fuel reprocessing plant was tested with slightly different flow sheets. The first fuel charge was removed from the Halden Boiling Water Reactor and new fuel is being installed. The biological investigation of the river Nitelva proceeded and the effects of radioisotopes on organisms and fish were investigated. (auth)

6803 (NBS-Mon-21) SPECIFIC HEATS AND ENTHALPIES OF TECHNICAL SOLIDS AT LOW TEMPERATURES. A Compilation from the Literature. Robert J. Corruccini and John J. Gniewek (National Bureau of Standards, Washington, D. C.). Oct. 3, 1960. 21p.

Tables are given of the specific heat and the enthalpy of 28 metals, 3 alloys, 8 other inorganic substances, and 8 organic materials, in the temperature range of 1 to 300°K. (auth)

6804 (NP-11218) THE TRANSMISSION OF STRESS WAVES AT AN INTERFACE SEPARATING LIQUID AND VOIGT SOLID. C. C. Mow (Mitre Corp., Bedford, Mass.). Oct. 1961. Contract AF33(600)-39852. 28p. (SR-28)

The problem of wave transmission between liquid and visco-elastic solid of Voigt-type is solved. Results indicated that for low-frequency waves the transmission coefficient is the same as that for wave transmission between a liquid and an elastic solid, and that the transmission coefficient for the high-frequency components approaches that of the rigid boundary case. Numerical results are obtained for intermediate frequencies. (auth)

6805 (ORNL-3213) SOLID STATE DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING AUGUST 31, 1961. (Oak Ridge National Lab., Tenn.). Dec. 29, 1961. Contract W-7405-eng-26. 166p.

Progress in solid state physics is reported on the following topics: theory, metals and alloys, nonmetals, reactor materials, and special projects. Twenty-one separate abstracts were prepared. (M.C.G.)

6806 (ORNL-3213(p.3-8)) RANGES OF PRIMARY ATOMS. M. T. Robinson, D. K. Holmes, and O. S. Oen (Oak Ridge National Lab., Tenn.).

Theoretical calculations were performed to determine the ranges in solids of atoms having energies from 250 ev to 200 kev. The work made use of Monte Carlo techniques on an IBM 7090 computer. The lattice atoms of the solid were assumed to be randomly located in such a manner as to preserve the density of the crystal. The collisions between the moving primary atom and the lattice atoms are assumed to be binary. For most of the work to date, a screened Coulomb potential and a hard-sphere approximation to the screened Coulomb potential were used to represent the interaction between the colliding atoms. (auth)

6807 (ORNL-3213(p.9)) ELECTRON CROSS SECTIONS FOR ATOMIC DISPLACEMENTS. O. S. Oen (Oak Ridge National Lab., Tenn.).

A calculational program was recently undertaken for theoretically computing the number of atomic displacements in solids by irradiation with fast electrons. The aim of the program is to supplement the rather limited number of theoretical calculations reported in the literature. (auth)

6808 (ORNL-3213(p.9-10)) ELECTRON TRANSPORT IN A MAGNETIC FIELD. J. H. Barrett (Oak Ridge National Lab., Tenn.).

The kinetic coefficients which relate the electrical and thermal currents to the electrical and thermal gradients were calculated for a free electron model. One result is that the Seebeck and Ettingshausen-Nernst effects are almost purely oscillatory for strong magnetic fields and low temperatures. (auth)

6809 (ORNL-3213(p.11)) STATISTICAL MECHANICS OF NONMETALLIC CRYSTALS. J. W. Miller and H. C. Schweinler (Oak Ridge National Lab., Tenn.).

An IBM 7090 computer program was written for hole and electron concentration in the valence and conduction bands, respectively, of nonmetallic crystals, under quite general assumptions. It is being extended to include space and time variation of acceptor and donor concentration. (auth)

6810 (ORNL-3213(p.15-23)) LOW-TEMPERATURE IRRADIATION STUDIES. R. R. Coltman, T. H. Blewitt, et al. (Oak Ridge National Lab., Tenn.).

Damage rates and isochronal annealing data for W, Mo, Ni, Pb, Sn, Na, and graphite irradiated near 4°K were obtained. An interesting anomaly was found in the resistivity

behavior of Na. Using a new technique for specimen isolation the stored energy arising from B^{10} fission damage in copper was measured as a function of temperature. The associated resistivity changes were measured on the same sample. Estimates of defect concentration and resistivity per defect were made. The resistivity and length changes associated with B^{10} fission damage in copper were measured simultaneously. Isochronal annealing data are presented from which some conclusions can be made concerning the annealing processes and the properties of the defects involved. Recent improvements to the low-temperature irradiation facility are described. A bombardment temperature of 3°K can now be maintained at full reactor power. Experiments were conducted on the tensile deformation of twinning in silver. Samples were deformed at 4.2, 77, and 300°K. (auth)

6811 (ORNL-3213(p.24-30)) DISLOCATION INTERACTIONS. D. O. Thompson and V. K. Paré (Oak Ridge National Lab., Tenn.).

Measurements of internal friction and modulus defect at 15 kc were used to study, in the neighborhood of room temperature, the pinning of dislocations in copper crystals by fast-neutron-induced defects. By measuring at various constant temperatures the delayed pinning following a short irradiation, a delay-time distribution for the pinning defects was obtained and the process was found to be governed by a single activation energy, 1.1 ev. Although this energy is reasonable for the diffusion of vacancies to dislocations, the shape of the delay-time distribution does not agree with theory, and the apparent number of jumps at the end of the process is anomalously low. Measurements of the internal friction of copper as a function of temperature from 220 to nearly 400°K after a neutron irradiation of about 1×10^{14} nvt indicated a defect-controlled spectrum in which the defect's activation energy for motion plays a role. The present spectrum is characterized by activation energies of 0.39 ev at the low-temperature side and 0.56 ev at the high-temperature side. (auth)

6812 (ORNL-3213(p.43-4)) PROPERTIES OF HIGH-PURITY IRON. J. C. Wilson (Oak Ridge National Lab., Tenn.).

A digital recording system for handling all data from internal friction, resistivity measurement, creep, and other types of experiments, with a 90% reduction in man-hours, is nearing completion. Twinning in iron at room temperature, when intergranular fractures occur, is attributed to high microscopic strain rates produced in grains whose boundaries participate in the fracture process. (auth)

6813 (ORNL-3213(p.44)) SINGLE-CRYSTAL SPHERES OF COPPER, SILVER, AND GOLD GROWN FROM THE MELT. M. C. Wittels, F. A. Sherrill, and J. O. Stiegler (Oak Ridge National Lab., Tenn.).

Single-crystal spheres of copper, silver, and gold, ranging in diameter from 75 to 600 μ, were grown by the Bridgman technique (slightly modified) in graphite crucibles. The surface-tension properties and freedom from foreign inclusions are important in minimizing multiple nucleation. (auth)

6814 (ORNL-3213(p.45-6)) $Au_{0.82}Hg_{0.18}$: A TRANSMUTATION ALLOY. M. C. Wittels, J. O. Stiegler, and F. A. Sherrill (Oak Ridge National Lab., Tenn.).

Single-crystal spheres of gold <0.015 in. in diameter were subjected to thermal-neutron fluxes of sufficient magnitude to produce 18 wt % of mercury in gold by transmutation at ~85°C. A solid-solution-alloy single crystal resulted, which under normal thermodynamic conditions cannot form below ~400°C. (auth)

6815 (ORNL-3213(p.47-9)) ELECTRON MICROSCOPE STUDIES. T. S. Noggle and J. O. Stiegler (Oak Ridge National Lab., Tenn.).

Electron microscope studies of fission-fragment tracks in thin films indicated that tracks arise from electron excitation and ionization; however, the different behavior of metal films and UO_2 suggested basically different mechanisms by which tracks are produced in the thin films in metals as compared with UO_2. Twenty-four-Mev nitrogen ion irradiation of thin platinum films produced narrow tracks which are different from those produced by fission fragments. (auth)

6816 (ORNL-3213(p.49-53)) Ar^+ ION BOMBARDMENT OF SOLID SURFACES (COPPER, GERMANIUM, AND INDIUM ANTIMONIDE). A. L. Southern, M. T. Robinson, et al. (Oak Ridge National Lab., Tenn.).

Yields are reported for Ar^+ ions of normal incidence upon polycrystalline and monocrystalline copper and upon monocrystalline germanium. These ratios were determined at ion energies from 1 to 5 kev. Atom ejection patterns were obtained for the three major planes of a copper monocrystal, for copper surfaces not aligned with the principal direction, and for one plane of indium antimonide. Patterns with structure could not be obtained for any of the principal planes of germanium in the energy range studied. The ion beam was analyzed for neutral argon atoms and $(4 \pm 3)\%$ of the beam consisted of neutral particles. Therefore the experimental uncertainty, taking into consideration instrument error, neutrals, and double-charged ions, is ±8%. (auth)

6817 (ORNL-3213(p.57-80)) SEMICONDUCTOR STUDIES AND STUDIES OF INSULATORS. O. L. Curtis, Jr., S. Othmer, et al. (Oak Ridge National Lab., Tenn.).

Additional measurements were made to determine the activation energy of the annealing of recombination centers in germanium. In addition, lifetime measurements are being extended to lower temperatures. Initial results demonstrated interesting behavior in this range. An extensive study was made of radiation-induced recombination centers in germanium. The results emphasized the importance of doping impurities in radiation-effects studies. An analysis which correlated the various types of behavior observed, using different kinds of radiation and different doping impurities, was performed. In connection with the measurement of thermoelectric power of germanium, methods were developed for scanning the sample temperature and for automatic recording of the experimental parameters. Two gamma irradiations were made on 2-ohm-cm n-type germanium. The Seebeck coefficient, Hall mobility, and carrier concentration were measured. Introduction rates for net acceptor levels at 0.17 and 0.5 ev below the conduction band were determined in a number of silicon samples that were grown by a vacuum floating-zone technique. These were compared with introduction rates in pulled samples, which contain considerably more oxygen. The 0.17-ev acceptor level, which was attributed to a center composed of an oxygen atom and a vacancy, was introduced in all samples of resistivities greater than 1 ohm-cm. The deep level was strongly dependent upon oxygen content and resistivity, appearing more rapidly in material of low oxygen content and low resistivity. The introduction rates of the two acceptor centers were also compared in identical samples irradiated with gamma rays of different intensities. For a difference of a factor of 3 in the photon flux, no change in introduction rate per incident gamma ray was

observed. Some early measurements on the introduction of net donors in p-type silicon indicated that the introduction of these centers, too, may be affected by the oxygen content of the silicon. The annealing of germanium which was previously irradiated by Co^{60} gamma rays at 77°K showed that the annealing involves at least two processes. One process has an activation energy of 0.787 ev. Nuclear reactions accompanying thermal-neutron capture in semiconductors were employed to examine recoil effects, chemical impurity introduction, and impurity compensation effects. A replacement-type collision model, which accounts for the fact that the transmuted atoms exert their expected influence on carrier concentrations irrespective of whether or not the specimen was thermally annealed, is discussed. Work on Cu_2O during the last year was directed toward a better understanding of the conditions necessary for single-crystal preparation and the factors that influence grain growth. The temperature range of 1000 to 1130°C is being explored for parameters associated with this grain growth. One inflection in the resistivity of the sample is reported. The original gamma facility No. 1 was emptied and water-cooled and will be reloaded with ~11,000 curies of Co^{60}, providing a central intensity of $\sim 10^7$ r/hr. Comparison of the optical absorption in the F band of KCl with the paramagnetic contribution to the low-temperature susceptibility yielded values for the oscillator strength of the F band of 0.9 and 0.7, respectively, in additively and irradiation-colored material. Bleaching and annealing produced M centers in the samples. Changes in the optical absorption and magnetic properties were consistent with a model recently proposed, in which two F centers coalesced to form an M center, which absorbed light both in the M and F band. The Curie points of K_2ReCl_6 and K_2ReBr_6 obtained from magnetic susceptibility measurements were 12.4 ± 0.5 and 15.3 ± 0.5°K, respectively, which confirmed that cooperative-type transitions observed in the heat capacities of these compounds with maxima at 11.9 ± 0.1 and 15.2 ± 0.1°K, respectively, represent transitions to the antiferromagnetic state. Evidence is presented that the ratios of the next-nearest-neighbor to nearest-neighbor superexchange interactions in the two compounds are approximately equal. An estimate of the spin-orbit coupling constants in the crystals is given and compared with other estimates. Samples of zirconia were doped with depleted and enriched uranium concentrations of the proper magnitude so that the effects of fast neutrons, fission fragments, and uranium as a chemical impurity could be assessed. The results indicated that the monoclinic-to-fcc phase transition is produced by fission fragments only, not by fast neutrons, and that uranium, as a chemical impurity in concentrations less than 0.4 wt %, does not act as a catalyst or stabilization nucleus for the transformation. A cryostat for thermal conductivity measurements between 2 and 100°K is being constructed. (auth)

6818 (ORNL-3213(p.81-90)) COVALENT CRYSTALS AND GLASSES. R. A. Weeks, C. T. Butler, et al. (Oak Ridge National Lab., Tenn.).

A hydrogen-free silica was heated in H_2O vapor at 900°C for increasing periods of time. The intensity of the E_1' center for constant gamma-ray irradiation dose was observed as a function of the intensity of the stretching mode of the hydroxyl group at 2.7 μ. The relation derived from these observations is $\eta_{E_1'} = b - a\,\eta_{(OH)}$, where $\eta_{E_1'}$ = concentration of E_1' centers, $\eta_{(OH)}$ = concentration of OH bonds, and b and a are constants. On the basis of this result, it is suggested that the OH enters the silica in such a way as to destroy E_1' sites, or else to prevent the E_1' sites from trapping electrons. The concentration of E_1' centers in silica was measured by static magnetic susceptibility and electron spin resonance techniques. The concentrations measured by the two techniques were in good agreement. The concentration thus measured was used to calculate an oscillator strength, f, for the optical absorption of the E_1' center, and it was found that f = 0.16. The g tensors of the E_2' centers in irradiated quartz single crystals were calculated. Each line, observed for c axis parallel to H orientation, has six sites per unit cell and each is approximately axially symmetric; however, for the line ($g_{c\ axis}$ = 2.0008) $g_1 = 2.0015$, $g_2 = g_3 = 2.00057$, and for the line ($g_{c\ axis} = 2.0010$) $g_1 = 2.0022$, $g_2 = 2.00067$, $g_3 = 2.00050$. It may be that the E_2' centers have their origin in the removal of an O ion and the subsequent trapping of an electron on the uncompleted Si orbital. The optical absorption from 1 ev to 8.5 ev in a single crystal of synthetic quartz was observed as a function of Co^{60} gamma irradiation followed by heat treatments, and subsequent reirradiation. Electron spin resonance measurements on the same specimen were used to observe the Al resonance. A threefold increase in the Al resonance after the second irradiation was not accompanied by an increase in the optical absorption in the 4600-A region. Concentration measurements of the Al resonance indicated that most of the Al present in the crystal was in substitutional positions. These results raised questions with respect to the correlation of the ESR signal with the optical bands in the region of 4600 A and have raised doubts about the diffusion mechanism which was proposed to explain the enhancement of the optical absorption in this region. A simplified calculation of the electric-field intensity inside a gamma-irradiated lead-glass window failed to account for the planar discharges observed in such windows, though such a field seems sufficient to aid in the propagation of a discharge initiated by other means. The optical absorption properties of Co^{60}-irradiated fused silica and crystalline quartz were studied in the vacuum-ultraviolet region. (auth)

6819 (ORNL-3213(p.91)) CERAMICS. C. D. Bopp, O. Sisman, and R. L. Towns (Oak Ridge National Lab., Tenn.).

The annealing of some of the radiation-induced property changes of ceramic materials is being studied by thermal analysis. Apparatus was constructed which is suitable for samples weighing about 1 g. (auth)

6820 (ORNL-3213(p.92-5)) POLYMERS. W. W. Parkinson, W. K. Kirkland, and O. Sisman (Oak Ridge National Lab., Tenn.).

The relative rates of cross-linking of polystyrene by gamma radiation alone and by the mixed neutron and gamma radiation of a reactor were determined by measurements of the fraction soluble and by swelling in toluene. The first determination is independent of the degree of branching, while the latter is independent of both the branching and the molecular-weight distribution. Both methods indicated that a given degree of cross-linking requires that the gamma-radiation dose be about 2.3 times as high as mixed reactor radiation. Analyses were performed for trace impurities which could have increased the dose in the reactor through neutron absorption reactions. The dose contributed by the impurity content was calculated to be negligible. Sets of simultaneous equations established from known solutions of hydrocarbon standards were solved for the infrared spectral absorption of two polybutadienes. The fraction of the theoretical total unsaturated groups found was 0.89 and 0.82 for the two samples, one high in terminal unsaturated groups, the other

high in trans groups. Previous analyses of radiolysis products of beryllium acetate complex were supplemented by measurements of the insoluble residue in the samples and by mass spectral analysis of the evolved gases. About 0.5% insoluble material was produced by 2.4×10^{20} ev/g. The ratio of D_2 to CD_4 was 4:3, including light hydrogen compounds, in the evolved gas. (auth)

6821 (ORNL-3213(p.95-102)) RADIATION DOSIMETRY. C. D. Bopp, W. W. Parkinson, et al. (Oak Ridge National Lab., Tenn.).

Colorimetric measurements were made of the gamma heating of magnesium and bismuth in Hole 71 of the ORNL Graphite Reactor. Since the photoelectric absorption of bismuth is large at low energy, an accurate knowledge of the gamma-radiation spectrum is required to estimate self-shielding. An estimate consistent with the experimental results is given by a spectrum calculated from a differential energy spectra tabulation. Chemical dosimeters are less complex than calorimeters; however, the usual dosimeters measure energy from fast-neutron and thermal-neutron interactions. A nonhydrogenous fluorocarbon organic chloride system was calibrated with gamma sources with a view to future use in reactor dosimetry. (auth)

6822 (ORNL-3213(p.105-24)) FUEL MATERIALS. O. Sisman, J. G. Morgan, et al. (Oak Ridge National Lab., Tenn.).

Postirradiation evaluation studies were performed on both beryllium- and stainless-steel-canned UO_2 fuel elements. The beryllium-canned fuel rods were supplied by the French Commissariat a l'Energie Atomique, the United Kingdom Atomic Energy Authority, and Oak Ridge National Laboratory. Although no large dimensional instability was experienced by any of the fuel elements, failures occurred in the UKAEA capsules. Exposures of 2500 Mwd per metric ton were reached at clad temperatures of 1100°F. Other fuel materials examined after irradiation were UC_2 dispersed in graphite and UO_2–BeO mixtures. The UC_2 dispersed in graphite and canned in graphite showed uranium and fission product diffusion into the can wall. The UO_2–BeO samples showed a dimensional increase of 3%. Examinations were also carried out on fuel elements under development for the Maritime and Fast Breeder Reactor Programs. The continuous release of fission gas from UO_2 was studied in both reducing and slightly oxidizing atmospheres. The gamma-ray spectrometer analysis of the fission-gas release was markedly different in the two cases. An increase of gas release was noted upon both heating and cooling. (auth)

6823 (ORNL-3213(p.124-33)) NUCLEAR METALS. O. Sisman, W. E. Brundage, et al. (Oak Ridge National Lab., Tenn.).

Tube burst (stress-rupture) tests were operated in the Oak Ridge Research Reactor with specimens of Inconel, type 304 stainless steel, niobium–1% zirconium alloy, Zircaloy-2, and beryllium. The data from special heats of Inconel did not prove the theory that boron causes the lowered rupture strength under irradiation. Irradiation considerably lowered the tangential strain at rupture for the Inconel and type 304 stainless steel specimens. Preliminary results indicated that irradiation reduces the rupture strength of niobium–1% zirconium by 12 to 15% and that no drastic change is to be expected for Zircaloy-2. (auth)

6824 (ORNL-3213(p.137-9)) EFFECT OF REACTOR IRRADIATION ON NICKEL–IRON ALLOYS. D. S. Billington, R. H. Kernohan, et al. (Oak Ridge National Lab., Tenn.).

Magnetic hysteresis loops were measured on six different nickel-iron alloys during a low-temperature irradiation in the Graphite Reactor, after the irradiation, and during a subsequent heat treatment. No significant changes were noted in the coercive force and remanence of most of the materials until during the heat treatment. Presumably, irradiation-induced defects became mobile in the range of 200 to 350°C. (auth)

6825 (ORNL-3213(p.139-40)) SEARCH FOR SUPERCONDUCTORS OF HIGH CRITICAL TEMPERATURES AND HIGH CRITICAL FIELDS. H. C. Schweinler and S. T. Sekula (Oak Ridge National Lab., Tenn.).

The superconducting transition temperatures of a series of Nb–Zr alloys were determined. The results obtained are qualitatively understood as arising from a variation in electronic density of states at the Fermi surface through the entire compositional range. (auth)

6826 (ORNL-3213(p.141)) RECOILLESS GAMMA EMISSION (MÖSSBAUER EFFECT). H. S. Pomerance (Oak Ridge National Lab., Tenn.).

Studies are being made of the nuclear resonant absorption of the 77-kev level of Au^{197}, using Pt^{197} as a gamma-ray source. (auth)

6827 (UCRL-9865) ELECTRON DRIFT, DIFFUSION, AND IONIZATION MEASUREMENTS IN HYDROGEN WITH CROSSED ELECTRIC AND STRONG MAGNETIC FIELDS (thesis). Melvin J. Bernstein (California. Univ., Berkeley. Lawrence Radiation Lab.). Oct. 4, 1961. Contract W-7405-eng-48. 74p.

A strong magnetic field is one in which the electron cyclotron frequency is much larger than the elastic-collision frequency with neutral molecules ($\omega^2\tau^2 >> 1$). Expressions for the energy distribution, drift velocities, and diffusion coefficients derived from the Boltzmann equation are simplified in the limit of a strong magnetic field. The energy distribution is Maxwellian with an average energy of $ME^2/2\eta B^2$, where M is the molecular mass; η is one for elastic collisions and larger than one when inelastic energy losses are significant. Experiments were done in a coaxial cylindrical geometry in which a steady electric field was perpendicular to a steady magnetic field. The ratio of the perpendicular ($\underline{E} \times \underline{B}$) to transverse ($\underline{E}$) drift velocities ($12 < \omega\tau < 48$) and the coefficient for diffusion in the parallel ($\underline{B}$) direction ($3 < \omega\tau < 8$) were determined. Measurements show that the average energy of the electrons is a function only of E/B, as predicted by theory. Curves were obtained for hydrogen, deuterium, and helium which give the transverse drift velocity in terms of the parameters E/B and B/p. Comparison of drift velocity and diffusion measurements yields an elastic cross section which is somewhat larger in the range of 0.3 to 4 ev than previously obtained by other methods. The average energy of electrons in hydrogen and deuterium as a function of E/B was determined in the range of 0.3 to 5 ev. The ionization coefficient α/p was measured across a strong magnetic field. Data were obtained by varying the gap in a cylindrical geometry. Measurements were made for B/p up to 4000 gauss/mm Hg and for an effective E/p′ less than 150. A theoretical expression of Blevin and Haydon is shown to fit the points well over a limited range of values. The effective collision frequency that makes the theory fit is much smaller than the actual average collision frequency. Analysis shows that this discrepancy results from deviations in the distribution function. (auth)

6828 ON MOVING STRIATIONS OF LOW PRESSURE MERCURY DISCHARGES. G. Lakatos and J. Bitó (Industrial Research Inst. for Telecommunication Technique,

Budapest). Acta Phys. Acad. Sci. Hung., 13: 193-201(1961). (In English)

The propagation velocity of the moving striations appearing in low pressure mercury vapor discharge tubes in the case of direct current was examined. Also, the influence of applied argon pressure on the velocity, when the vapor pressure of mercury was kept approximately constant, was determined. (auth)

6829 THE CORRELATION ENERGY AND THE CORRELATION POTENTIAL OF AN ELECTRON GAS. P. Gombás (Univ. of Technical Sciences, Budapest). Acta Phys. Acad. Sci. Hung., 13: 233-9(1961). (In German)

An interpolation formula valid for the entire density range was derived for the correlation energy of an electron gas. On the basis of this formula, the correlation interaction of electrons in the highest filled energy state with ordinary electrons was represented by a correlation potential. (tr-auth)

6830 THE INFLUENCE OF EXTERNAL RESISTANCE ON THE MOVING STRIATIONS OF THE POSITIVE COLUMN. G. Lakatos and J. Bitó (Industrial Research Inst. for Telecommunication Technique, Budapest). Acta Phys. Acad. Sci. Hung., 13: 245-7(1961). (In English)

The dependence of the frequency and other parameters of moving striations in low pressure gas discharge on the magnitude and kind of external limiting element was studied. The experimental conditions are described. The results show that the magnitude of the external limiting ohmic resistance affects the amplitude of light intensity oscillation of the moving striations and its speed and wavelength. However, the frequency is not affected. The frequency is affected by the presence of the inductive part of external limiting element. (J.S.R.)

6831 ROTATION SPECTRUM OF C^{13}-ENRICHED VINYL BROMIDE. R. E. Goedertier (Université, Louvain, Belg.). Ann. soc. sci. Bruxelles. Sér. I, 75: 174-82(1961). (In French)

The rotation spectrum of $C^xH_2C^yHBr^z$ (x = 12, 13; y = 12, 13; z = 79, 81) is studied at 14.8 to 24.6 kMc. The spectral shape is used to calculate several of the structural properties. (T.F.H.)

6832 REMARKS ON THE INFRARED SPECTRA OF DEUTERIUM-SUBSTITUTED VINYL BROMIDES. C. P. Courtoy (Facultés Universitaires Notre-Dame de la Paix, Namur, Belg.). Ann. soc. sci. Bruxelles. Sér. I, 75: 183-7 (1961). (In French)

The structures of a certain number of perpendicular bands of deuterium-substituted bromoethylene are obtained between 750 and 1100 cm^{-1}. The molecules studied include cis and trans $CH_2 = CDBr$, $CD_2 = CHBr$, $CD_2 = CDBr$, and $CHD = CHBr$. Some results are obtained concerning the rotation constants. (tr-auth)

6833 NOTE ON SOME POSSIBLE METASTABLE STATES OF H_2^-. Inga Fischer-Hjalmars (Royal Inst. of Tech., Stockholm). Arkiv Fysik, 20: 461-2(1961). (In English)

The Σ states of H_2^- are investigated using a molecular orbital method. Numerical H_2^- calculations were carried out using a machine program for the IBM 704 computer, giving self-consistent molecular orbitals as well as matrix elements of the Hamiltonian operator. Calculated energy values are tabulated. Comparisons are made with previous results, and significant differences are found. (L.N.N.)

6834 NOTE ON THE FIELD METHOD OF OBTAINING THE CONSERVATION LAWS AND SOLVING THE TWO BODY PROBLEM IN GENERAL RELATIVITY. M. Demiański and E. Infeld (Univ. of Warsaw). Bull. acad. polon. sci., Sér. sci., math., astron. et phys., 9: 693-6 (1961). (In English)

Conservation laws up to the post Newtonian approximation are derived straight from the field equations. A simple method of solving the equations of motion for the body problem without the use of the Lagrangian and without writing them out explicitly is obtained. (auth)

6835 ON TRANSITIONS INVOLVING CROSSING OF POTENTIAL ENERGY SURFACES. A. Witkowski (Jagellonian Univ., Krakow). Bull. acad. polon. sci., Sér. sci., math., astron. et phys., 9: 697-700(1961). (In English)

A system of nuclei and electrons representing reacting quasi-molecules or stable states of polyatomic molecules is considered. Two potential energies are allowed to cross. The crossing occurs in a point for a diatomic molecule and the energies interact. Equations are presented for the theory of non-adiabatic reactions, and a limiting case is shown. (L.N.N.)

6836 VIBRATIONAL STUDY OF THE STATES $B'\ ^1\Sigma_u^+(3p)$ AND $B''\ ^1\Sigma_u^+(4p)$ IN THE MOLECULES H_2, HD, AND D_2. André Monfils. Bull. classe sci., Acad. roy. Belg., (5) 47: 599-606(1961). (In French)

The transitions $B'\ ^1\Sigma^+(3p) \leftarrow X\ ^1\Sigma_g^+(1s)$ and $B''\ ^1\Sigma_u^+(4p) \leftarrow X\ ^1\Sigma^+(1s)$ are studied in the absorption spectra of H_2, HD, and D_2. The vibrational constants are calculated, and these constants permit the determination of the isotopic shifts. The state $B''\ ^1\Sigma_u^+(2p)$ may be understood as a term having a Rydberg-series quantum number n = 4, and containing the states $B\ ^1\Sigma_u^+(2p)$ and $B'\ ^1\Sigma_u^+(3p)$ as lower terms. (tr-auth)

6837 STATES $D\ ^1\pi_u(3p)$ AND $D'\ ^1\pi_u(4p)$ IN THE MOLECULES H_2, HD, AND D_2. André Monfils. Bull. classe sci., Acad. roy. Belg., (5) 47: 816-23(1961). (In French)

The transitions $D\ ^1\pi_u \leftarrow X\ ^1\Sigma_g^+$ and $D'\ ^1\pi_u \leftarrow X\ ^1\Sigma_g^+$ in the molecules H_2, HD, and D_2 are analyzed. The electronic terms, the vibrational constants, and the isotopic shifts are calculated. A state (named D') is found, that may be characterized as $^1\pi_u(4p)$. (tr-auth)

6838 THE RAMAN SPECTRA OF LIQUID AND SOLID H_2, D_2, AND HD AT HIGH RESOLUTION. S. S. Bhatnagar, Elizabeth J. Allin, and H. L. Welsh (Univ. of Toronto). Can. J. Phys., 40: 9-23(Jan. 1962).

The Raman spectra of liquid (18°K) and solid (2°K) n-H_2, p-H_2, n-D_2, o-D_2(80%), and HD were photographed with a reciprocal linear dispersion of 3 to 6 cm^{-1} but the Q_1 vibrational lines are very sharp. The $S_0(0)$ transition of p-H_2 and o-D_2 is a triplet of sharp lines, but the corresponding transition in HD is not split. The vibrational frequencies in the liquid are lowered by 7 to 9 cm^{-1} and in the solid by 8 to 11 cm^{-1} from the gas values. The vibrational shifts in the various solids are correlated by representing them as the sums of shifts due to dispersion forces, overlap forces, and vibrational coupling. (auth)

6839 ABSORPTION OF AN ELECTROMAGNETIC RADIATION (INFRARED) BY A "PLASMA BLOWPIPE" JET. Joseph Chapelle, François Cabannes, Alassane Sy, and Christiane Cabannes (C.N.R.S., Bellevue, France). Compt. rend., 253: 1318-20(Sept. 25, 1961). (In French)

An effort was made to determine the properties of a "plasma blowpipe" jet by studying the absorption of electromagnetic waves with frequencies close to the plasma frequency (infrared). (tr-auth)

6840 THE MOVEMENT OF MAGNETIC FIELDS. John Carstoiu (Science for Industry, Inc., Brookline, Mass.). Compt. rend., 253: 1397-9(Oct. 2, 1961). (In French)

The electromagnetic potential vector A and its relation with the Clebsch transformation are analyzed. (J.S.R.)

6841 ELECTRON INJECTION IN AN ION BEAM: NON-LINEAR PHENOMENA. Jean-Michel Dolique. Compt. rend., 253: 1414-16(Oct. 2, 1961). (In French)

It has been shown in a previous article (Compt. rend. 253: 818(1961)) that a permanent regime for electron injection in an ion beam exists only if the densities of electron and ion currents were equal $\underline{n}_e(z)\underline{v}_e(z) = \underline{n}_i\underline{v}_i$. The variation relative to the neutrality $\underline{u}(z) = \underline{n}_e(z)/\underline{n}_i - 1$ (and then the variation relative to the equality of the mean electron and ion velocities) is treated as a perturbation ($\underline{u} \ll 1$): the equations linear in $\underline{u}$. In the present article the permanent injection regimes in which the variation relative to neutrality (or to the equality of mean electron and ion velocities) is anything are studied. (tr-auth)

6842 THEORY OF ADIABATIC WAVES ASSOCIATED WITH THE NON-DIAGONAL TERMS OF THE PRESSURE TENSOR IN PLASMAS. Jean-Loup Delcroix, Jean-François Denise, Daniel Quémada (Laboratoire des Hautes Energies, Orsay, France and Observatoire de Meudon, France). Compt. rend., 253: 1417-19(Oct. 2, 1961). (In French)

The propagation of monochromatic plane waves in a homogeneous plasma placed in a magnetic field is studied with the aid of hydrodynamic theory, the non-diagonal terms of the pressure terms being assumed nonzero and the system of macroscopic equations being closed by the relation $\vec{\nabla} \cdot \vec{\vec{Q}} = 0$. For $B_T = 0$, the longitudinal waves are identical to those found in the adiabatic theory with scalar pressure and the fast transverse waves differ very little. In the region of slow waves, new transverse waves appear, the existence of which appears very debatable. Finally, in the vicinity of cyclotron resonances, bands appear where the dispersion is abnormal. (tr-auth)

6843 CRITIQUE OF THE LANDAU ABSORPTION AND OF THE LINEAR APPROXIMATION IN THE STUDY OF PLASMA OSCILLATIONS. Jean-François Denisse (Observatoire de Paris-Meudon). Compt. rend., 253: 1539-41(Oct. 9, 1961). (In French)

It is shown that the integral which leads to the dispersion equation of plasma oscillations should be taken in the sense of a principal part. This means that the Landau absorption should not exist for plasma oscillations. (tr-auth)

6844 STATIONARY IONIC OSCILLATIONS IN HIGH FREQUENCY PLASMOIDS IN ABSENCE OF MAGNETIC FIELD. Richard Geller and Michelle Lucarin. Compt. rend., 253: 1542-4(Oct. 9, 1961). (In French)

In the absence of static magnetic fields, high-frequency plasma can be the seat of stationary oscillatory phenomena caused by ionic vibrations. The phase velocity of waves thus produced is of the order of $(3\ KT^-/m^+)^{1/2}$ and depends then on the ionic mass and the electron temperature in the plasma. Experimental results confirm this phenomenon. (tr-auth)

6845 SECONDARY ELECTRON EMISSION OF METALLIC TARGETS BOMBARDED WITH IONS OF MEDIUM ENERGY (10–110 KEV). Nicole Colombie and Phan Van Chuong. Compt. rend., 253: 1567-9(Oct. 9, 1961). (In French)

A description is given of the experimental apparatus used in a study of secondary electron emission. The coefficients of secondary electron emission for copper, nickel, cobalt, and silver bombarded with 10 to 100-kev argon ions were determined. (tr-auth)

6846 EFFECTS OF ELECTRICAL CONDUCTIVITY AND VISCOSITY IN THE PROPAGATION OF MAGNETOHYDRODYNAMIC WAVES. John Carstoiu (Science for Industry, Inc., Brookline, Mass.). Compt. rend., 253: 1653-4(Oct. 16, 1961). (In French)

In a previous note (Compt. rend. 252: 2070(1961)) the effect of electric conductivity on the propagation of magnetohydrodynamic waves in a perfect fluid and the effect where the conductivity is so high that the viscosity effect can be neglected were studied. In the present article, the combined dissipation effects of conductivity and viscosity were investigated. (tr-auth)

6847 NUCLEAR MAGNETIC RESONANCE OF THE Fe^{57} NUCLEUS IN THE LOCAL FIELDS OF SEVERAL Fe-RARE EARTH GARNETS. Le Dang Khoi and Maurice Buyle-Bodin (Faculté des Sciences, Grenoble, France and Laboratoire d'Electrostatique et Physique du Metal, Grenoble, France). Compt. rend., 253: 2514-16(Nov. 27, 1961). (In French)

The nuclear resonance of Fe^{57} in the local fields of X-Fe garnets (X = Gd, Tb, Dy, Ho, Y, Er, Tm, Yb, or Lu) is studied. By comparison of the results, the effect of the point of compensation on the resonance is confirmed, and the dependence of the magnetization of the Fe sublattice on the size of the crystalline cell is determined. (tr-auth)

6848 A POSSIBLE CRITERION OF SUPERCONDUCTIVITY. I. M. Chapnik (Novosibirsk State Univ., USSR). Doklady Akad. Nauk S.S.S.R., 141: 70-3(Nov. 1, 1961). (In Russian)

Values of the Hall coefficient R, the interplanar distance $\underline{d}$, and type of crystal structure are presented for a number of superconductors. The Hall coefficient R is positive for 15 of 21 superconductors ($R > 0$), the value of d is greater than 2.6 to 2.9 kX, but less than 4 kX, and superconductors are not ferromagnetic or strongly paramagnetic. It is presumed that hole conduction is necessary for the occurrence of superconductivity (the concentration of holes should be greater than 10^{19} cm^{-3}). Impurities and thermal treatment change the magnitude and sign of R, especially in Ti and Hf, and it is known that the critical temperature is also affected by the presence of impurities and by the thermal treatment. It is probable that an increase in hole concentration by means of a low-temperature deformation of the massive metal is the cause for bringing Mo, Ir, and Sb into a state of superconductivity. The value of R in superconducting films of Bi is smaller by a factor of 1000 than the value of R for the solid Bi metal. It is known that the addition of Fe, Cr, and Co impurities to the superconductors Ti and Zr results in an increase in the critical temperature. It would be interesting to investigate the effect of these impurities on the value of the Hall constant. It may be possible to prepare a superconductor by obtaining a high concentration of holes ($N_p \sim 10^{21}$ cm^{-3}) by means of alloying a semiconductor with an impurity which would give a compound with the proper interplanar distance $\underline{d}$, or by alloying α-Sn with Al or In. (TTT)

6849 DIFFUSION OF IODINE IN COMPRESSED CARBON DIOXIDE NEAR ITS CRITICAL POINT. I. R. Krichevskii, N. E. Khazanova, and L. R. Linshits (State Scientific Research and Planning Inst. of Nitrogen and Organic Synthesis, USSR). Doklady Akad. Nauk S.S.S.R., 141: 397-9 (Nov. 11, 1961). (In Russian)

In view of its ability to form visible colored mixtures with gases, iodine was chosen for studying molecular diffusion in CO_2 near the critical point. The method used was based on the work of R. Fürth (J. Sci. Instr. 22, 61

(1945)) on the determination of diffusion coefficients in colored liquids. The measurement was based on the determination of the time required for a given gas volume at a certain distance to reach a coloration identical with that of the reference, calculating the coefficient of diffusion from the formula $D = (l^2/2t)$ where l = distance and t = time. The lowest value that can be determined with the method is 1×10^{-7} cm^2 sec^{-1}. The diffusion coefficient of I in liquid CO_2 was found to be 1.5×10^{-5} cm^2 sec^{-1} which agrees with previous data. Measurements in the gas phase were carried out at 31.5°C at densities below and above the critical value. Results indicate a complete absence of diffusion near the critical point, while under conditions further removed the diffusion rate was found to be same as for compressed gases in general. This confirms previous conclusions that at the critical point the Brownian movement ceases, resulting in stoppage of the diffusion phenomenon. (TTT)

6850 HYDROMAGNETIC WAVES IN A COMPRESSIBLE FLUID. C. Devanathan and P. L. Bhatnagar (Indian Inst. of Science, Bangalore, India). J. Indian Inst. Sci., 43: 179-94(Oct. 1961). (In English)

The equations satisfied by vorticity and current density are derived for a compressible infinitely-conducting fluid in the presence of a magnetic field. It is shown that the components of vorticity and current density along the direction of the magnetic field will be propagated with Alfven velocity only if the charge separation takes place in the medium. The propagation of the disturbance caused by homogeneous and inhomogeneous condensations at a point in the medium are considered. Finally, a proof of Walen's problem, namely an annular disturbance is propagated along the magnetic lines of force with Alfven velocity without distortion, is given. (auth)

6851 DIFFERENTIAL ROTATION IN SLOWLY DISSIPATING SYSTEMS. Nandor L. Balazs (Princeton Univ., N. J.). Phys. Fluids, 5: 57-68(Jan. 1962).

If a body does not rotate uniformly it suffers differential rotation. Under certain conditions the existence of differential rotation of a body is a consequence of quite general properties of dissipative processes. Let E be the kinetic energy of rotation, A and I the angular momentum and the moment of inertia along the axis of rotation; then the body cannot rotate rigidly unless the positive semidefinite form $K = E - A^2/2I$ vanishes. If this condition is not satisfied, the motion of the system can still be specified provided the relaxation time for establishing a steady state corresponding to a given value of the energy and angular momentum is much less than the relaxation times of the energy and angular momentum. If this be the case, the steady state of the system can be approximated with a state in which the dissipation is a minimum subject to the constraints that E and A have fixed values. This leads to the investigation of states of least dissipation subject to auxiliary conditions. The resulting eigenvalue problem is solved for several simple models in which the dissipation is due solely to viscous friction. If the values of E and A specified through the auxiliary conditions do not make K vanish, the models exhibit differential rotation. (auth)

6852 ABSORPTION OF ELECTROMAGNETIC RADIATION BY AN ELECTRON GAS. Narkis Tzoar and Abraham Klein (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 124: 1297-1306(Dec. 1, 1961).

The total absorption cross section for a photon by an electron gas is calculated in the high-density limit. The calculation makes use of the Green's function formulation of the many-body problem. Only the simplest final states leading to a nonvanishing cross section, consisting of an electron-hole pair and a plasmon, are taken into account. This contribution has a threshold near the plasmon energy and is peaked owing to the initially rapid rise of the available phase space, with a total cross section for real metals of $10^{-17} - 10^{-19}$ cm^2 per electron. This compares favorably with other absorption mechanisms. (auth)

6853 LANDAU DAMPING TO ALL ORDERS. David Montgomery (Univ. of Wisconsin, Madison) and David Gorman. Phys. Rev., 124: 1309-13(Dec. 1, 1961).

Recent results for an asymptotic series expansion of the nonlinear equations for an electronic plasma in the "collisionless" regime are extended. Substantially, the result is that for a wide class of initial disturbances, the presence of the so-called "Landau damping" in first order indicates its persistence to all orders in perturbation theory. Similarly, exponentially growing solutions in first order imply their existence in all higher orders. The problem is considered both from the Laplace transform point of view, and by normal modes. (auth)

6854 COLLECTIVE BEHAVIOR IN SOLID-STATE PLASMAS. David Pines and J. Robert Schrieffer (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Rev., 124: 1387-1400(Dec. 1, 1961).

The conditions for the existence of plasma wave instabilities in the plasma formed by the electrons and holes in semiconductors are discussed. The dispersion relations for both the high-frequency optical mode in which electrons and holes move out of phase, and the low-frequency acoustic mode in which electrons and holes move in phase are calculated. Growing acoustic waves are shown to occur for a sufficiently large relative drift velocity of the electrons and holes, and the boundary between growing and damped waves is determined for various electron-hole temperature ratios. Growth rates are calculated for several cases of interest; when the influence of impurity and phonon scattering on the electron-hole behavior is taken into account it is concluded that InSb is perhaps the most promising semiconductor in which to observe such instabilities. An investigation of the hole and electron temperatures and the relative electron-hole drift velocity as a function of field strength is carried out for InSb. It is shown that moderate field strengths (~100 v/cm) suffice to produce electron-hole drifts of the required order of magnitude for the observation of plasma wave instability; however, the scattering mechanisms present are sufficiently effective that it appears marginal whether the other condition (long hole relaxation times) necessary for the observation of the plasma wave instability is achievable in practice. Conditions for the occurrence of similar plasma wave instabilities in semimetals are analyzed briefly. (auth)

6855 IONIZATION OF NITROGEN MOLECULES BY NITROGEN MOLECULES. Nyle G. Utterback and Glenn H. Miller (Univ. of Denver). Phys. Rev., 124: 1477-81(Dec. 1, 1961).

The ionization cross section for N_2 molecules on impact with N_2 molecules was measured over the laboratory energy range from 30 to 1000 ev. The incident molecular beam was produced by the technique of ionization by electron impact, electrostatic acceleration and neutralization by charge transfer. The measurements were carried out in a low-pressure parallel plate ionization chamber. Particular attention was paid to the problem of secondary electrons. Ionization was observed a few volts above threshold. Cross sections which were obtained ranged from 10^{-20} to 10^{-16} cm^2. The curve of cross section vs incident

particle energy showed structure indicative of competing processes. (auth)

6856 ENHANCEMENT OF THE LONG-LIVED POSITRONIUM ANNIHILATION RATE BY A STATIC ELECTRIC FIELD. A. Bisi, A. Fasana, and L. Zappa (Istituto di Fisica del Politecnico, Milan). Phys. Rev., 124: 1487-8(Dec. 1, 1961).

The annihilation rate of the long-lived component of positronium in solid dielectrics was investigated as a function of an applied static electric field. It was found that in some materials like paraffin, polyethylene, and Teflon the triplet positronium decays, in the presence of the field, at a rate grater than the usual "pick-off" annihilation rate. Within the experimental accuracy the lifetimes τ in the three materials display the same trend with the field, which is expressed by the equation $\tau_E = \tau_0 (1 - \alpha E)$, where $\alpha = (9.3 \pm 1.3) \times 10^{-4}$ cm/kv. No effect was found in some typical polar polymers, for instance, Lucite, Nylon, and polyvinyl chloride. (auth)

6857 INSTABILITIES OF A CYLINDRICAL ELECTRON-HOLE PLASMA IN A MAGNETIC FIELD. Maurice Glicksman (RCA Labs., Princeton, N. J.). Phys. Rev., 124: 1655-64(Dec. 15, 1961).

The stability of an electron-hole plasma carrying current in a parallel magnetic field is investigated. The theory employed is a generalization of a previous treatment applied to gas discharges. In its generalized form it is applicable to plasmas produced either by injection or by impact ionization and no restrictions are placed upon the magnitude of the magnetic field, provided the classical linearized treatment is appropriate. The possibility of finite plasma densities at the surface of the crystal is included in an approximate manner. Instabilities are predicted, and the calculated values of the electric field, magnetic field, and lowest oscillation frequency which occur at the onset of instability are compared with available observations, including those of the Oscillistor. Agreement is reasonably satisfactory. (auth)

6858 VARIATIONAL DERIVATION OF THE STEADY STATE. Ryoichi Kikuchi (Hughes Research Labs., Malibu, Calif.). Phys. Rev., 124: 1682-91(Dec. 15, 1961).

For a system undergoing Markoffian irreversible change of state, a concept of persistency (shown to arise naturally from a physical microscopic description of the system) is introduced; it is defined as the probability that a certain state persists during a short time interval without drifting away from the state. This concept is used in deriving a theorem which says that "the steady state of a Markoffian irreversible process corresponds to the maximum of the persistency." This theorem holds even outside the range of validity of Prigogine's principle of minimum entropy production, namely, even when the steady state is not close to the equilibrium state or even when the process is nonlinear. The proposed function is derived from the path probability for irreversible statistical dynamics previously reported. The theorem is first applied to a system of two level atoms interacting simultaneously with a heat bath and a radiation field. Next, Kohler's variational derivation of the Boltzmann transport equation is shown to follow from the theorem. (auth)

6859 PATH INTEGRAL IN IRREVERSIBLE STATISTICAL DYNAMICS. Ryoichi Kikuchi and Peter Gottlieb (Hughes Research Labs., Malibu, Calif.). Phys. Rev., 124: 1691-6(Dec. 15, 1961).

Extending the path probability method for irreversible statistical dynamics proposed previously, the two-gate probability distribution for a stochastic Markoffian system is written in the form of a path integral. The most probable path is derived as a solution of the variational Euler-Lagrange equation. Introducing the concept of the anticausal path, a method to calculate the one-gate probability distribution function (for fluctuations away from the nonequilibrium steady state) is explained. The distribution function derived recently for a system of many levels is shown to follow. The concept of the pseudo-entropy $\tilde{S}$ is introduced. $\tilde{S}$ always increases in time as the system approaches its steady state. It is shown that the rate $d\tilde{S}/dt$, rather than dS/dt of Prigogine, is minimum in the steady state, although the latter can serve as an approximation when the steady state is near equilibrium. (auth)

6860 PARTITION FUNCTION CUTOFF AND LOWERING OF THE IONIZATION POTENTIAL IN AN ARGON PLASMA. H. N. Olsen (Linde Co. Speedway Labs., Indianapolis). Phys. Rev., 124: 1703-8(Dec. 15, 1961).

A comparative value for the lowering of the ionization potential in an argon plasma was determined from values of the series limits for recombination of free plasma electrons into the 1s and 2p states of the argon atom obtained from the measured frequency dependence of the electron continuum. The results were used to compare existing theories which relate the ionization potential lowering to the electron density and temperature. (auth)

6861 PROPERTIES OF INJECTED PLASMAS IN INDIUM ANTIMONIDE. Betsy Ancker-Johnson, Roger W. Cohen, and Maurice Glicksman (RCA Labs., Princeton, N. J.). Phys. Rev., 124: 1745-53(Dec. 15, 1961).

Plasmas composed of injected electron-hole pairs in p-type indium antimonide were studied. The injection times were measured and pinching of the plasma was observed. The current-voltage curves show a steep rise at voltages well below those required for breakdown, indicating a large increase in carrier density before breakdown. The Hall voltage measured as a function of current changed sign from that expected for hole transport to that expected for electron transport. Negative resistances were observed in the plasma in the presence of transverse magnetic fields. Longitudinal magnetic fields decreased the plasma density, probably because of an increased radial diffusion of the plasma to the surface. Coherent oscillations were observed on top of the pinch both with and without longitudinal fields, and their dependence on current and magnetic field is described. (auth)

6862 DIAGRAMMATIC EXPANSION FOR THE ISING MODEL WITH ARBITRARY SPIN AND RANGE OF INTERACTION. Gerald Horwitz and Herbert B. Callen (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 124: 1757-85 (Dec. 15, 1961).

A new and simple diagrammatic expansion is developed for the free energy of the Ising model with arbitrary spin and range of interaction. The contribution of each diagram is a product of the reciprocal of the order of the symmetry group of the diagram, a product of semi-invariants, with a factor M_N for each spin in the diagram (n being the number of bonds joined to that spin), and a sum of products $\Sigma_{i,j,k} \cdots (2\beta J_{ij})(2\beta J_{kl}) \ldots$, where $2\beta J_{ij}$ corresponds to a bond between spins i and j, and where the summation is carried out with no restrictions on the summation indices (no "excluded volume" corrections). The expansion variables are the spin deviation operators $\sigma_i \equiv \bar{S} - S_{iz}$. The quantity $\bar{S}$ is chosen to eliminate a large class of diagrams; this choice also minimizes the corresponding free-energy contribution and implies $\bar{S} = \langle S_{iz} \rangle$. By further renormalization of the

vertices all reducible (simply articulated) diagrams are eliminated. To zero order the molecular field solution is obtained. The next approximation consists of the summation of renormalized simple loop diagrams. The justification of this choice of diagrams rests, at low temperature, on the decrease of the value of the higher order semi-invariants, on the relationship of these loop diagrams to the random phase approximation, and on the agreement with the rigorous low-temperature series result. At the Curie temperature the same choice of diagrams is justified by a modification of the 1/z criterion, so that the expansion can be viewed as an expansion in 1/z, where z is the effective number of spins interacting with a given spin. Finally the choice of loop diagrams is justified at high temperature by exact agreement to second order in T_c/T (and by a very close agreement to fourth order) with the rigorous high-temperature series expansion. Thus the theory agrees with rigorous results in the low-temperature and paramagnetic regions and has a well-defined criterion of validity in the intermediate temperature region. For nearest-neighbor interactions and spin $\frac{1}{2}$ the specific heat is continuous through the Curie temperature, with an infinite slope on the low-temperature side of the transition. (auth)

6863 ENERGY BANDS IN LITHIUM. Joseph Callaway (Univ. of California, Riverside). Phys. Rev., 124: 1824-7 (Dec. 15, 1961).

A previous calculation of energy bands in lithium which employed the orthogonalized plane wave method, was extended with the determination of the energies of states along the [100], [110], and [111] axes in the Brillouin zone. The Fermi energy was also determined. The Fermi surface predicted by these calculations is not in contact with the Brillouin zone, and is only slightly distorted from the sphere characteristic of free electrons. (auth)

6864 EFFECT OF SPIN-EXCHANGE COLLISIONS ON THE OPTICAL ORIENTATION OF ATOMIC SODIUM. L. Wilmer Anderson and Alan T. Ramsey (Univ. of Wisconsin, Madison). Phys. Rev., 124: 1862-5(Dec. 15, 1961).

The effect of spin-exchange collisions on the state populations obtained in an optically pumped Na^{23} vapor is studied in the limit of low light intensity. These state populations and hence the intensity of the rf Zeeman transitions are found theoretically to depend strongly on the spin-exchange cross sections. The various Zeeman rf transitions are found experimentally to be very different in intensity and this is interpreted as being partially due to spin-exchange collisions. From the intensity of the rf transitions in a magnetic field large enough to separate the six Zeeman components and from the observed relaxation time a spin-exchange cross section for two sodium atoms of $\pi S_0^2 = 6 \times 10^{-14}$ cm^2 is found. (auth)

6865 BETA-GAMMA PHASE TRANSFORMATION IN SOLID He^3. J. P. Franck (National Research Council, Ottawa). Phys. Rev. Letters, 7: 435-7(Dec. 15, 1961).

Measurements of the specific heats of He^3 and He^4 are made at high densities. A calorimetric investigation of the $\beta-\gamma$ phase transformation in solid He^3 is made. The $\beta-\gamma$ phase boundary close to its intersection with the melting line is established, and the latent heat of transformation is obtained. Results, presented graphically and tabularly, are used to calculate the change in entropy and molar volume upon transformation. (L.N.N.)

6866 ION-PAIR RESONANCE MECHANISM OF ENERGY TRANSFER IN RARE EARTH CRYSTAL FLUORESCENCE. F. Varsanyi and G. H. Dieke (Johns Hopkins Univ., Baltimore). Phys. Rev. Letters, 7: 442-3(Dec. 15, 1961).

It is shown that one photon can excite two ions simultaneously. Hexagonal $LaCl_3$ crystals are initially used. The La^{3+} ions are replaced by Pr^{3+}. The pure $PrCl_3$ is illuminated with light of frequency 20475 cm^{-1}, and the P_0^2 state is excited. Fluorescence from this level is observed, and the same spectrum appears when the frequency of excitation is changed such that higher electronic levels are excited. The observed simultaneous excitation of two ions corresponds classically to the appearance of combination frequencies when two oscillators of different frequencies are linked by nonlinear forces sufficiently weak as not to affect the frequencies seriously. (L.N.N.)

6867 PROPERTIES OF He^3 AT PRESSURE NEAR THE MINIMUM IN THE MELTING CURVE. Henry A. Fairbank (Yale Univ., New Haven). Phys. Rev. Letters, 8: 49-52(Jan. 15, 1962).

At pressures slightly above that of the melting curve minimum and at temperatures below 0.1°K, measurements of sound propagation, magnetic susceptibility, nuclear spin relaxation times T_1 and T_2, and the diffusion coefficient suggested solid-like behavior, while the specific heat was characteristic of the liquid. It is shown that these properties are those expected in a liquid-solid mixture and that the He^3 sample used was probably in a mixed phase during the measurements. (L.N.N.)

6868 CORRELATION OF RESONANCE CHARGE EXCHANGE CROSS-SECTION DATA IN THE LOW-ENERGY RANGE. John W. Sheldon (National Aeronautics and Space Administration, Cleveland). Phys. Rev. Letters, 8: 64-5 (Jan. 15, 1962).

Charge-exchange cross sections for Ar^+ in Ar and Xe^+ in Xe are considered. Extrapolation of the data of R. M. Kushnir et al. (Bull. Acad. Sci. U.S.S.R., Phys. Ser. 23, 995(1959)) was made in accordance with T. Holstein's theory (J. Phys. Chem. 56, 832(1952)), a combination of time-dependent perturbation methods and classical orbit theory. Results of this theory may be discussed in terms of a critical impact parameter b_c. For $b < b_c$, the probability, P, of charge exchange is a rapidly oscillating function of b with extremes at 0 and 1 and an average of $\frac{1}{2}$. For $b > b_c$, P rapidly drops from $\frac{1}{2}$ to 0 with increasing b. Satisfactory data are obtained. (L.N.N.)

6869 THE APPLICATION OF RELATIVISTIC ELECTRODYNAMICS OF ELECTRONS TO THE TECHNOLOGY OF MILLIMETER AND SUBMILLIMETER WAVELENGTHS (RADIATION). Józef Szpilecki (Katedra Fizyki Politechnikei Slaskiej, Gliwice, Poland). Postępy Fizyki, 12: 423-42(1961). (In Polish)

The production of microwaves of millimeter and submillimeter wavelengths is treated from both the theoretical and mechanistic points of view. Radiation of charged particles is treated for the cases of (1) uniform, linear motion of a charged particle (Cherenkov effect), (2) non-linear motion of a particle of fixed velocity (i.e., motion in a magnetic undulator), and (3) motion of charged particles undergoing rapid acceleration (i.e., impulse due to nuclear electric fields and electronic gases). The conditions that determine the applicability of classical electrodynamics are discussed. Some newer devices for producing millimeter and submillimeter electromagnetic radiation are presented, including the rebatron, the harmodotron and microtron. (TTT)

6870 NEUTRONS AS A TOOL FOR INVESTIGATING AUTODIFFUSION IN LIQUIDS. J. A. Janik (Jagellonian Univ., Krakow). Postępy Fizyki, 12: 467-76(1961). (In Polish)

A brief review of methods available for determining dy-

namic parameters of liquids is given, followed by an intensive treatment of the application of neutron scattering to the problem of investigating autodiffusion, and with it the local atomic and molecular structure of liquids. The local structure of a liquid can be either quasi-crystalline or quasi-gaseous, in the extremes. Autodiffusion in a quasi-crystalline model takes place by quantized change of state with the local structure preserving its form for finite intervals of time, whereas in the quasi-liquid case, the local structure is continuously undergoing change. The scattering of monoenergetic neutrons by water is compared with scattering from molten lead because the asymmetric water molecules are expected to exhibit localized structure while lead molecules are not. The coefficient of autodiffusion, as measured by low-energy monoenergetic neutrons and by beryllium-filtered cold neutrons, is expected to be lower for water when compared to measurements of autodiffusion in water by other means. This is due to the fact that the neutron interaction time is not long compared to the relaxation time of the quasi-crystalline local structure of water. In the case of liquid lead, on the other hand, the coefficient of autodiffusion as measured by neutron scattering is expected to agree with the value obtained by established methods. Several experimental results are reviewed, results that are not in complete accord with the above picture; nor are these results mutually consistent. The areas of necessary future investigation are pointed out. (TTT)

6871 TRANSITION RADIATION AND THE VAVILOV-CHERENKOV EFFECT. I. M. Frank. Uspekhi Fiz. Nauk, 75: 231-40(Oct. 1961). (In Russian)

Investigations based on the Vavilov-Cherenkov effect led to developments exceeding the framework of the original theory. The new fields include fast-particle effects in plasma in magnetic fields, Vavilov-Cherenkov effects in crystals, etc. An important field is presented by the so-called "transition radiation" which arises when fast-moving charged particles pass from one medium into another, in particular when they impinge on metallic targets coming from vacuum. Although the theory was elaborated as early as 1944 by V. L. Ginsburg and the author, experimental verification was obtained only recently. If the energy of the particles is sufficiently high, they may penetrate into the metal to a depth exceeding the wavelength. The metal exerts a screening effect for certain wavelengths and for certain wavelengths and angles the transition radiation behaves as if it were suddenly stopped at the metal boundary. The radiation was observed in accelerators, cathode-ray tubes and other experimental devices in which fast moving charged particles collide with a metallic target and it always accompanies cathodic luminescence. The radiation yield is proportional to the square of the charge; for non-relativistic energy ranges it is proportional to the square of the velocity. In the case of relativistic particles the metal may be replaced by a transparent dielectric without loss of intensity. This field of study promises to be of great interest for clarifying our concepts of the interaction of short-wave radiation with high-energy particles. (TTT)

6872 THE DIRECT CONVERSION OF THERMAL ENERGY INTO ELECTRICAL ENERGY. N. D. Morgulis. Vestnik Akad. Nauk S.S.S.R., 31: No. 9. 25-31(Sept. 1961). (In Russian)

Thermoelectric, thermoelectron, and magnetohydrodynamic energy converters are discussed. Thermoelectric converters use a semiconductor with a high thermoelectromotive force. The semiconductor should have a high electrical conductivity, a low thermal conductivity, and a high temperature difference for the hot and cold junctions. PbTe is one of the best materials for this purpose. With a hot junction temperature of 600°C and a cold junction temperature of 20°C, the theoretical Carnot efficiency of about 66% is lowered to about 12% due to irreversible losses. The output voltage is about 0.1 volt, and the over-all energy conversion is about 6 to 8% for PbTe. The compound NiO is stable up to about 1100°C. Under these conditions the theoretical Carnot efficiency of 80% for NiO is lowered to 11% with an output voltage of about 0.3 volts. It is predicted that the efficiency of these materials can be raised to 20–30% in the near future. A thermoelectron converter is based on the flow of thermal electrons from a hot cathode to a cold anode in a vacuum (0.01 to 1.0 mm Hg std). The cathode temperature is 1200 to 2800°C, and high-temperature materials such as UC, ThC_2, Ta, and W are used as cathode materials. Cesium is used to neutralize the space charge. The anode temperature should not exceed 800°C. The efficiency is about 15%, and the specific power is 15 to 30 watts/cm^2 of cathode area. The output voltage of 1 to 2 volts is low. Because of the high temperature of the cold sink (800°C at the anode), a thermoelectron converter having an efficiency of 30% can be used in conjunction with a thermoelectric converter having an efficiency of 20% to give an over-all efficiency of 44%. A thermoelectron converter operating directly in a nuclear reactor gave 90 watts of power at a power density of 21 watts/cm^2 with an efficiency of about 10%. Another thermoelectron converter operating on the discharge gases from a rocket as a source of heat produced 270 watts at an efficiency of about 8% with a total weight of 1.6 kg for the unit. A magnetohydrodynamic converter depends on the excitation of an electrical current in a conductor moving in a transverse electrical field. In this case the moving conductor is a plasma of hot ionized gases. These devices are useful only at a high power output exceeding 1000 kilowatts. It has been calculated that a typical converter having a power output of 10^5 kilowatts can operate on a plasma created by burning fuel containing 1% potassium at 2200°C. The gas velocity is about 10^5 cm/sec, and the magnetic field has a strength of about 10^4 oersteds. The efficiency can attain 60%. (TTT)

6873 THE PROBLEM OF THE SATURATION OF THE LUMINESCENCE OF ZnS CRYSTALS. I. Broser and W. Klein (Max-Planck-Gesellschaft, Berlin). Z. Naturforsch., 16a: 894-902(Sept. 1961). (In German)

The intensities of various emission bands in ZnS single crystals were measured in dependence on the 60 kv electron beam density (10^{-10} up to 1 amp/cm^2) and the temperature (80 to 450°K). The linear luminescent characteristics at low electron beam densities change into some bands in a sublinear region, in which the luminescence increases with the root of the excitation intensity, and gradually become linear again. The sublinear region is displaced with increasing temperature to lower electron beam densities. At 10^{-1} amp/cm^2 and over, site heating by the electron beam plays a roll. This is shown in estimations of the temperature increase and temperature coefficient. If the temperature coefficient is negative, the warming is brought about in such a way that the luminescence increases more slowly or even with increasing excitation intensity decreases. The luminescence increases superlinearly with the excitation when the luminescence yield has a positive temperature coefficient. In the crystals studied there was no real saturation of the luminescence. These results are in agreement with the Riehl-Schon model for the light mechanism in ZnS phosphors. The concept of saturation of light centers was not necessary. (tr-auth)

6874 THE LUMINESCENT PROPERTIES OF ZnS-Cu IN DEPENDENCE ON THE METHOD OF PREPARATION. H. Ortmann and H. Hartmann (Deutsche Akademie der Wissenschafte, Berlin). Z. Naturforsch., 16a: 903-9(Sept. 1961). (In German)

The various effects of the method of preparation on the luminescent properties of ZnS(Cu) luminophors are indicated. The precipitation method plays in this respect a significant and often overlooked roll. The possibility of preparing ZnS phosphors at low temperatures is discussed. The occurrence of two different Cu emission bands is seen in connection with the crystal structure of the system, for which the results of the Temper series correspond. The growth of ZnS single crystals, their luminescence, and diffusion processes of Cu are described. (tr-auth)

6875 THE SPECTRAL DISPLACEMENT OF THE EMISSION BANDS OF VARIOUSLY ACTIVATED (Zn : Cd)S MIXED CRYSTAL LUMINOPHORS. H. Ortmann and H. Treptow (Physikalisch-Technisches Institut, Deutsche Akademie der Wissenschaften, Berlin). Z. Naturforsch., 16a: 910-16(Sept. 1961). (In German)

The Cu, Ag, and self activated luminophors of the ZnS–CdS mixed crystal series were prepared from the same basic materials and their emission under UV excitation was measured. It was shown that the band displacement in the different activations proceeded in the same direction but not parallel. The effect of the crystal structure on the site of the band maximum was shown. The band displacements at lower temperatures are basically different for the activation studied, which indicates variations in the central structure. (tr-auth)

6876 INDIUM AS COACTIVATOR IN ZnS-Cu LUMINOPHORS. G. Wendel (Physikalisch-Technisches Institut, Deutsche Akademie der Wissenschaften, Berlin). Z. Naturforsch., 16a: 916-20(Sept. 1961). (In Berlin)

If indium diffuses at about 500°C into a ZnS luminophor, there is no essential change of the emission spectrum. By the subsequent diffusion of copper into the crystal, a broad orange-red emission with a maximum at about 6700 Å occurs. The band can occur with copper concentrations as small as 2×10^{-6} g Cu/g ZnS. The necessary copper and indium concentration is dependent on the glow atmosphere of the initial luminescent material. The long-wave emission was, in contrast to the red copper emission, not affected by the presence of oxygen or the introduction of halogen ions. On the basis of the research it is suggested that this emission be ascribed to an associated copper-indium light center. (tr-auth)

6877 ANHYDROUS ZINC BORATE AS A HOST CRYSTAL IN LUMINESCENCE. S. Terol and Maria J. Otero (Instituto de Optica "Daza de Valdés," Madrid). Z. Naturforsch., 16a: 920-7(Sept. 1961). (In English)

In preparing zinc borate luminophors, the best results are obtained by thermal treatment from melts of $ZnO : B_2O_3$ in proper molar proportions. Compositions between 50 and 61% ZnO give transparent glasses, which yield separable cubic crystals by devitrification. A compound of molar relation 4 $ZnO : 3\ B_2O_3$ not reported in the literature is deduced from a re-examination of the chemical and structural constitution of these crystals. This compound–more properly expressed $OZn_4(BO_2)_6$–possesses a crystalline structure of the sodalite (ultramarine) type. Each unit cell contains two molecules of metaborate. This crystal shows a violet emission band under 2537 Å and cathode ray excitation. When the molar ratio is 2 : 1 (70% ZnO), or higher, the devitrification gives no single crystal, but a product of yellow luminescence under 2537 Å excitation consisting of a glassy phase and crystals which are not cubic. Preparations of intermediate composition show the presence of both phases (cubic and non-cubic) each one associated with its luminescent band. Upon heating a non-cubic zinc borate in hydrogen part of the zinc is lost by reduction and subsequent volatilization, thus incurring a change to the cubic structure as a consequence of the composition change. The manganese has a valence of 2+, when incorporated to the cubic crystals, and gives rise to a strong green emission whereas the resulting luminescence in the non-cubic phase is orange and the valence is greater than 2+. No direct influence of the firing atmosphere on the valency of the activator has been found in the preparation of such products. When the orange-emitting phosphor is heated in a reducing atmosphere, however, the structural change from non-cubic to cubic is always associated with the change of the Mn emission band (orange → green) and a simultaneous valency conversion $Mn^{>2+} \rightarrow Mn^{2+}$. As, Sb, and Bi activated cubic zinc borates also create well defined emission bands. Arsenic incorporates as As^{5+}, antimony as Sb^{3+} and Sb^{5+}, whereas bismuth as Bi^{3+}. A speculation is made for the explanation of these effects. (auth)

6878 REMARKS ON THE NATURE OF THE LIGHT CENTERS IN ACTIVATOR-FREE ZnS LUMINOPHORS. W. van Gool and A. P. Cleiren (N. V. Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). Z. Naturforsch., 16a: 948-50(Sept. 1961). (In German)

If ZnS of fluorescent quality is grown with halogenides, a blue luminescence is observed during excitation with longwave UV. This luminescence originates in general by faults in the ideal lattice. The possible faults are an excess of zinc either in the interstitial site or on lattice sites, an excess of sulfur, chlorine on the sulfur planes, oxygen on the sulfur planes, or association of all these lattice faults. The possible contribution of each fault to the luminescence is discussed. (J.S.R.)

6879 FORMULAR REPRESENTATION OF THE IONIZATION CROSS SECTION WITH RESPECT TO ELECTRON COLLISION. H.-W. Drawin (EURATOM [Paris] and Commissariat à l'Énergie Atomique, Fontenay-aux-Roses, France). Z. Physik, 164: 513-51(1961). (In German)

An empirical analytical expression for the ionization cross sections is given which is in very good agreement with experimentally measured cross sections, and which is able to give a large part of the ionization curves as a function of the energy of the impacting electrons. For high electron energies the formula is in agreement with the quantum mechanical expression for the ionization cross section (Born-Bethe formula). (auth)

6880 IONIZATION IN THE COLLISIONS OF Ne^{n+} WITH Xe ATOMS AND OF Xe^{n+} WITH Ne ATOMS (n = 0,1,2,3,4). I. P. Flaks, G. N. Ogurtsov, and N. V. Fedorenko (Leningrad Inst. of Physics and Tech.). Zhur. Eksptl'. i Teoret. Fiz., 41: 1438-42(Nov. 1961). (In Russian)

The total ionization cross sections (σ_-) for single collisions between fast Ne^{n+} and Xe atoms and between fast Xe^{n+} and Ne atoms were measured. The fast particles possessed charges from 0 to 4 and were accelerated by a potential which varied between 3 to 30 kv. With increased fast particle charge the cross section was found to increase for the Ne^{n+}–Xe pair and to decrease for the Xe^{n+}–Ne pair. An analysis of elementary processes in which electrons are liberated from the shells of each of the colliding particles indicates that a dependence of this type could be expected. An increase of σ_- with increased fast partic-

charge is due to the possibility of exothermal ionization processes involving capture. An opposite type of dependence occurs when ionization with capture is an endothermal process and the main contribution to the cross section is from fast atomic particle stripping. (auth)

6881 IS ν_s OR $\nu_s - \nu_n$ THE CAUSE OF DESTRUCTION OF SUPERFLUIDITY? V. P. Peshkov and V. B. Stryukov (Inst. of Problems in Physics, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 41: 1443-8(Nov. 1961). (In Russian)

The critical velocities for the superfluid part, for the oppositely moving superfluid, and for the normal parts are determined from the attenuation of second sound in a capillary tube of 0.385-cm diameter. It is shown that superfluidity is destroyed as a result of movement of the superfluid part relative to the wall. (auth)

6882 HEATING OF A GAS BY RADIATION. A. S. Kompaneets and E. Ya. Lantsburg (Inst. of Chemical Physics, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 41: 1649-54(Nov. 1961). (In Russian)

Radiative propagation through a cold gas of heat initially contained in a finite region of the gas is considered. It is assumed that the temperature of the heated gas is so high that the gas within the region is transparent to the radiation. Expansion of the heated region occurs as a result of radiative heat exchange in the external opaque layer adjacent to the cold gas, radiative energy transfer in this layer being considered diffusion-like. The expansion process is regarded as a quasi-stationary propagation of the boundary of the heated region in the form of a plane wave moving across the cold gas. A method for calculation of the propagation velocity is indicated which takes into account the nonequilibrium state of the radiation within th inner transparent part of the heated region of the gas. (auth)

6883 COLLECTIVE EXCITATIONS IN A SUPERCONDUCTOR. V. G. Vaks, V. M. Galitskii, and A. I. Larkin. Zhur. Eksptl'. i Teoret. Fiz., 41: 1655-68(Nov. 1961). (In Russian)

Quantum field theory methods are employed for determining the collective excitation spectrum in a superconductor. Advantage is taken of the fact that superconductivity theory can be formulated as a one-dimensional relativistic problem. The Bethe-Saltpeter equation for two-particle Green's functions whose poles determine the excitation spectrum is written down in the weak coupling approximation. A sound waves branch in the neutral particle system is obtained which does not terminate for momenta $k \sim \Delta$ but continues into the region of large k, the excitation energy exponentially approaching 2Δ. In the case of charged particles, the dispersion of plasma oscillations is weakly affected by the superconductivity. A set of excitations with nonvanishing angular momenta is found; for small values of k their energy is close to 2Δ quadratically in the coupling constant. For each nonvanishing value of the projection of the angular momentum on the direction of k, there exists an excitation branch which does not terminate for small k. In the region of large k the energy of these excitations exponentially approaches 2Δ. (auth)

6884 THE PLASMA DISPERSION FUNCTION. The Hilbert Transform of the Gaussian. Burton D. Fried and Samuel D. Conte. New York, Academic Press, 1961. 422p. $12.00.

The Hilbert transform of a Gaussian together with its first derivative is tabulated for small amplitude waves or linearized disturbances in a very hot, not to dense, uniform plasma. The tabular material is preceded by a short expository section which summarizes some of the principal mathematical characteristics of the dispersion function, explains in detail its application to plasma physics problems, and discusses the numerical methods used to generate the tables. (N.W.R.)

Astrophysics and Cosmology

6885 NUCLEAR RADIATIONS WITH RESPECT TO SOME OF THE GREAT COSMOLOGICAL PROBLEMS. Ignacio Frisancho Pineda. Bol. inform. junta control energiá atőmica (Peru), 6: 17-24(July-Aug. 1961). (In Spanish)

The study of nuclear radiations has permitted data to be obtained which aid in the explanation of the origin of the energy of stars, the determination of the age of the earth, the study of the nature of the elementary particles constituting the matter of the universe, and the formulation of hypotheses on cosmic radiation. A brief survey is given of these four problems. (J.S.R.)

6886 NUCLEAR REACTIONS IN IRON METEORITES. A. P. Vinogradov, A. K. Lavrukhina, and L. D. Revina (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Geokhimiya, No. 11, 955-66(1961). (In Russian)

Iron spallation by cosmic particles is the chief nuclear process in iron meteorites. About 10^{-7} g/g of cosmogenic isotopes per gram of meteorite accumulate during 4.5×10^9 years. The stable isotopes Ar^{36}, Ar^{38}, K^{40}, Sc^{45}, and V^{50} in iron meteorites are of cosmogenic origin. Observed anomalies in the isotopic composition of argon and potassium may be explained by deep spallation reactions. For isotopes of vanadium and titanium and of other elements, the abundance of which is 10^{-6} to 10^{-7} g/g, shifts in the isotopic composition in iron meteorites relative to rocks of the earth may be expected. Equilibrium activity values were estimated for long-lived cosmogenic nuclei detected in iron meteorites. The average effective energy of nuclei formation $A \sim 20$ and ~ 40 was estimated. (auth)

6887 γ-γ COINCIDENCE MEASUREMENT FOR THE PERTURBATION-FREE MEASUREMENT OF THE CONCENTRATION OF POSITRON EMITTERS AND γ-ACTIVE ISOTOPES IN METEORITES. Chr. Gfeller, F. G. Houtermans, H. Oeschger, and U. Schwarz (Universität, Bern). Helv. Phys. Acta, 34: 466-9(1961). (In German)

A coincidence apparatus was used to measure the concentrations of Na^{22} and Al^{26} in two chondrites, Kandahar and Utzenstorf. In the Utzenstorf meteorite the Na^{22} had almost completely decayed. A formula for the spallation cross section was derived, using the measurement results. (J.S.R.)

Cosmic Radiation

6888 (FTD-TT-61-162) CONCERNING THE ORIGIN OF RING CURRENTS IN THE REGION OF THE VAN ALLEN RADIATION BELTS. R. Fiebig and H. Voelcker. Translated from Atomkernenergie, 6: 300-9(July-Aug. 1961). 31p.

Measurement of the earth's magnetic field in the region of the outer Van Allen radiation belt at geocentric distances ranging from 20,000 to 50,000 km shows two distinct anomalies traceable to ring currents. Interpretation of these currents as a consequence of particle motion in circular orbits in the geomagnetic equatorial plane is shown to be untenable. The complete statistics of the

particle paths in the radiation belt depict the desired ring currents as diamagnetic effects of the belt. A satisfactory agreement between the theoretical and the observed values is obtained with the aid of a simple model. (auth)

6889 LUNAR DIURNAL VARIATION OF THE NEUTRON COMPONENT OF COSMIC RAYS (USSR). L. I. Dorman and L. Kh. Shatashvili. Geomagnetizm i Aeronomiya, 1: 662-70(Sept.–Oct. 1961).

A study confirming the existence of lunar diurnal variation of the neutron component of cosmic rays shows that the lunar diurnal variation depends on the position of the sun, moon, and earth, reaching a maximum at half-moon and a minimum at new-moon. The latitude effect is also considered. The hypothesis is advanced that the lunar diurnal variation is caused by a distorted geomagnetic field, i.e., the displacement at high altitudes of the frozen-in magnetic lines of force which results from the action of solar and lunar gravity fields on the plasma of the earth's magnetosphere. A rough estimate based on this hypothesis agrees with experimental data. (OTS)

6890 MAGNETIC STORM EFFECTS IN COSMIC RAYS DURING MINIMUM SOLAR ACTIVITY (USSR). L. I. Dorman and V. K. Koyava. Geomagnetizm i Aeronomiya, 1: 839-41(Sept.–Oct. 1961).

The Forbush decrease was analyzed on the basis of data on 92 magnetic storms recorded with a shielded ionization chamber at Tbilisi in 1953-1955. It was observed that the Forbush decrease occurred only during large storms with sudden commencement; also, an increase in cosmic-ray intensity was registered prior to the commencement of such storms. The change in the cutoff point of the hard component was determined to be about the same during minimum and maximum solar activity, indicating that the nature of interaction between corpuscular streams and the geomagnetic field does not change greatly during minimum solar activity. The results of the analysis show that the corpuscular streams which cause large magnetic storms with sudden commencement are magnetized, that they contain a magnetic cushion in their forward part, and that they carry extensive high-intensity frozen-in magnetic fields. (OTS)

6891 NEUTRONS IN METEORITES. P. Eberhardt (Universität, Bern), J. Geiss, and H. Lutz. Helv. Phys. Acta, 34: 460-4(1961). (In German)

In calculating the cosmic radiation intensity along the path of a meteorite, it has been assumed that high energy spallation processes play the essential role. For more accurate discussions, however, lower energy processes, principally slow neutron capture, must be considered. The neutron fluxes encountered by a spherical meteorite of chondrite composition were calculated. The Co^{60}, Cl^{36}, and Ar^{36} induced in chondrites of 40 and 100 cm radius were calculated as examples. (J.S.R.)

6892 A NOTE ON THE UNUSUAL VARIATIONS OF COSMIC RAY INTENSITY DURING THE PERIOD 1960 NOVEMBER 10 TO 16. T. Mathews, T. Thambyahpillai, and W. R. Webber (Imperial Coll. of Science and Tech., London). Monthly Notices Roy. Astron. Soc., 123: 97-111 (1961).

A sequence of cosmic-ray variations, observed in London in connection with the high level of solar and geophysical activity prevailing during the period Nov. 10 to 16, 1960, is described. The results are compared with cosmic-ray observations made elsewhere and with other relevant geophysical phenomena. Some of the features encountered are unique in the type of event considered, and the implications of these results are briefly discussed. (auth)

6893 ENERGY SPECTRUM AND POSITIVE EXCESS OF MUONS IN COSMIC-RAY AIR SHOWERS. Stewart Bennett and Kenneth Greisen (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 124: 1982-7(Dec. 15, 1961).

A magnet spectrometer and an array of 15 large scintillator disks were used to examine the distribution of the muon component of extensive air showers with respect to both energy and distance from the axis. An empirical function which was found to be consistent with the observations is $\rho_\mu(N,r,\geq E) = [14.4r^{-0.75}/(1 + r/320)^{2.5}]\ (N/10^6)^{0.75}\ (51/E + 50)\ (3/E + 2)^{a(r)}$, with $a(r) = 0.14r^{0.37}$, where ρ_μ gives the average number of muons per square meter with energy exceeding E Bev at r meters from the axis of a shower that contains N charged particles. According to this relation, the mean energy at sea level of the muons in air showers is 7 Bev, and they carry, in a shower of N particles, an energy of $0.9 \times 10^{15}(N/10^6)^{0.75}$ ev. The positive excess which has been observed in muons examined independently of air showers was not found in the muons detected in the air showers. It is concluded that π-meson production dominates K-meson production by a factor of at least 10 in a region of meson energies about 10 Bev. (auth)

6894 VARIATION IN THE POSITIVE ION CONCENTRATION WITH ALTITUDE FROM DATA ON MASS SPECTROMETRY MEASUREMENTS ON THE THIRD SATELLITE. V. G. Istomin. Planetary Space Sci., 8: 179-82 (Dec. 1961). (In English) (Translated by R. Matthews from Iskusst. Sputniki Zemli, No. 6, p.127, 1961).

The amplitude of ion current peaks of different masses is a function of described variables and must depend on the concentration of the respective ions. Methods of obtaining the variables are discussed. The thermal velocities of the ions are assumed to be much smaller than the speed of the satellite. (L.N.N.)

6895 MEASUREMENTS OF ELECTRON CONCENTRATION IN THE IONOSPHERE UP TO ALTITUDES OF 420-470 km, CARRIED OUT DURING THE INTERNATIONAL GEOPHYSICAL YEAR BY MEANS OF RADIO-WAVE TRANSMISSIONS FROM THE GEOPHYSICAL ROCKETS OF THE ACADEMY OF SCIENCES, U.S.S.R. K. I. Gringauz and V. A. Rudakov. Planetary Space Sci., 8: 183-93 (Dec. 1961). (In English) (Translated by R. Matthews from Iskusst. Sputniki Zemli, No. 6, p.48, 1961).

Problems relating to methods for measuring radio-wave dispersion and the Faraday effect, as employed in the determination of the electron concentration, are examined. Results of measurements carried out during the launching of 3 geophysical rockets to 450 to 470 km altitude, in 1958, are presented. Measurements were performed at different times of the day and year, over the same geographical point, and by the same method. The n_e distribution with altitude was determined for the outer ionosphere. (L.N.N.)

6896 ON A SHORT-LIVED COSMIC RAY DECREASE ON NOVEMBER 13, 1960. I. Escobar, N. W. Nerurkar, O. Troncoso, and M. Zubieta (Universidad Mayor de San Andres, La Paz, Bolivia). Proc. Natl. Acad. Sci. U. S., 47: 1873-5(Dec. 1961).

Cosmic radiation was measured from 0900 to 2200 UT on Nov. 13, 1960 on Chacaltaya mountain, Volivia, using a cosmic neutron monitor designed for $12BF_3$ counters. Immediately after the magnetic storm that began at 1021 UT, the cosmic intensity decreased rapidly during the first hour and then followed the general pattern of the Forbush decrease. Shortly after 1300 UT, the intensity decreased suddenly and remained 3 to 4% below the former value for 1¼ hours, then jumped suddenly to predrop value.

Later, it continued to decrease for more than 6 hours, following the profile of the first decrease. Other monitors reported similar results and comparisons were made with similar phenomena occurring previously. It is suggested that intensity decreases are caused by a cloud of ionized solar gas with magnetic fields enveloping the earth. The clouds contain the storms within well defined regions, where the field strength is higher and radiation intensity lower than the rest of the cloud. When such a region moves past the earth, cosmic intensity decreases even more. (L.N.N.)

6897 SUPERNOVAE AS COSMIC-RAY SOURCES. Nonthermal Radio Emission and Polarized Light Illuminate an Old Problem. Maurice M. Shapiro (U. S. Naval Research Lab., Washington, D. C.). Science, 135: 175-93 (Jan. 19, 1962).

Certain characteristics of supernovae, inferred from observations and theories, are interpreted as suggesting that the young remnants of a supernovae eruption constitute a powerful source of cosmic rays. These features include an enormous energy release, a copious supply of relativistic electrons, large-scale magnetic fields, extended masses of plasma moving at high velocities, indications of the propagation of hydromagnetic waves, and relatively high concentrations of heavier elements. Recent evidence is reviewed which was obtained by the analysis of the continuous spectrum of electromagnetic radiations from the Crab Nebula, optical and nonthermal radio emissions, and photoelectric and photographic techniques employing polaroid filters. Notation, constants, and conversion factors used in the calculations are included. (Seventy-three references.) (C.H.)

6898 INVESTIGATION OF THE HIGH ENERGY μ-MESON FLUX OF BROAD AIR SHOWERS. B. A. Khrenov (Moscow State Univ.). Zhur. Eksptl'. i Teoret. Fiz., 41: 1402-11(Nov. 1961). (In Russian)

Results of an experimental study of the following average characteristics of μ-meson fluxes in broad air showers at sea level are presented: spatial distribution, dependence of μ-meson flux on total number of shower particles in the 5 to 10 Bev energy range and μ-meson density spectrum. (auth)

6899 ON SOME CHARACTERISTICS OF EXTENSIVE AIR SHOWERS. A. A. Pomanskii (Lebedev Inst. of Physics, Moscow). Zhur. Eksptl'. i Teoret. Fiz., 41: 1556-61 (Nov. 1961). (In Russian)

Calculations show that the decrease of the fraction of energy imparted to a π meson with increasing primary particle energy is not consistent with experimental data on the altitude dependence of extensive air showers. It is also shown that the number of nuclear-active particles in extensive air showers strongly depends on the fraction of baryons among the secondary particles produced in an elementary nuclear interaction event. (auth)

Criticality Studies

6900 (DC-57-5-78) TSM MEASUREMENTS REPORT NO. 2. H. L. Bermanis and B. W. Link (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). May 8, 1957. Contract AT(11-1)-171. 15p.

Reactivity and nuclear measurements on the HTRE-3 critical experiment mockup are presented. The experimental work was conducted on a core with a peripheral manual poison rod placement pattern. (J.R.D.)

6901 (NEPA-950) CRITICAL REACTOR REQUIREMENTS FOR URANIUM CARBIDE–BERYLLIUM CARBIDE–GRAPHITE SYSTEMS. T. R. Mitchell (Fairchild Engine and Airplane Corp. NEPA Div., Oak Ridge, Tenn.). Mar. 15, 1949. Contract [W-33-08-ac-14801(16250)]. 45p.

The criticality requirements of nuclear reactors using enriched UC_2 and moderated by Be_2C are given. Calculations were based on neutron diffusion theory and performed over wide ranges of core composition, reflector thickness, and free flow ratio. The results are presented graphically to show clearly the interrelations between reactor size, uranium requirement, reactor weight, core composition, reflector thickness, and free flow ratio. (auth)

6902 (NEPA-1263) CRITICAL MASSES IN OPERABLE, AIR-COOLED BERYLLIUM CARBIDE MODERATED REACTORS. T. R. Mitchell (Fairchild Engine and Airplane Corp. NEPA Div., Oak Ridge, Tenn.). Jan. 10, 1950. Decl. July 18, 1961. Contract [W-33-08-ac-14801(16250)]. 26p.

The criticality requirements of nuclear reactors at operating conditions are presented. The effects of high temperature, coolant, coating and fission product poisons were incorporated in the calculations for the determination of critical reactor sizes and uranium requirements after 100 hours of continuous operation at 600,000 kw. The assumptions for the reactors dealt with in this report are given. Calculations were based on neutron diffusion theory. The Fermi "Age" method was used to obtain bare reactor results, and both one and two group methods were used for reflected reactors. Computations were performed for reactors with 0", 3", and 6" reflectors, having free flow ratios of 0.2, 0.3, and 0.4, and over a wide range of uranium concentrations. The results are presented graphically to show the interrelations among reactor size, uranium requirement, reflector thickness, uranium concentration, free flow ratio and free flow area. A comparison is shown of the bare "operating effects" reactors with the "no effects" reactors. Two graphs are also included to give an indication of the energies of the neutrons that are causing fission in the various reactors considered. (auth)

6903 (NYO-9658) HEAVY WATER LATTICE RESEARCH PROJECT ANNUAL REPORT [ENDING] SEPTEMBER 30, 1961. T. J. Thompson, Irving Kaplan, and A. E. Profio, eds. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2344. 109p.

An experimental and theoretical program on the physics of heavy water moderated, partially enriched uranium metal lattices is being conducted. A subcritical assembly which uses the M. I. T. research reactor for the neutron source has been built. Theoretical and experimental research on buckling, fast fission, resonance capture, and thermal capture has been carried out for the calibration lattice of one-inch diameter natural uranium rods. Programs in pulsed neutron source research and reactor control research have been initiated. (auth)

6904 (TID-7619) PROCEEDINGS OF THE UNIVERSITY SUBCRITICAL ASSEMBLIES CONFERENCE HELD AT GATLINBURG, TENNESSEE, AUGUST 28-30, 1961. (Oak Ridge National Lab., Tenn.; Oak Ridge Inst. of Nuclear Studies, Inc., Tenn.; and American Nuclear Society, Chicago). Jan. 1962. 280p.

Seventeen papers are included which were presented at the 1961 University Subcritical Assemblies conference, whose purpose was to review the status, significance and service of various subcritical assemblies for college and university research and teaching programs in nuclear science and engineering. Separate abstracts were prepared

for 15 of the papers; the other two are a summary of the conference and a banquet address on the relationship between the national laboratory and the university. (D.L.C.)

6905 (TID-7619(p.1-15)) HISTORICAL ASPECTS OF SUBCRITICAL ASSEMBLIES. Lyle B. Borst (New York Univ., New York).

A brief review is presented on the history of subcritical assemblies after 1939, particularly on Fermi's work. The construction and performance of the New York University's "Pickle Barrel" assembly are described. Finally, the cascading of subcritical stages as in the Convergatron and a two-stage amplifier are discussed. (D.L.C.)

6906 (TID-7619(p.16-44)) VALUE OF SUBCRITICALS TO THE COLLEGE RESEARCH AND TEACHING PROGRAM. W. R. Kimel (Kansas State Univ., Manhattan).

The use of subcritical assemblies in the nuclear engineering program at Kansas State Univ. is described with reference to its graphite-moderated critical assembly. Theory is presented for measurements of thermal diffusion model parameters, diffusion length, Fermi age, etc., and experimental data are given for the graphite-moderated assembly. A group discussion is included in which remarks were made on the age measurements, the use of a small critical reactor as the neutron source, and the role of mathematics in the undergraduate program. (D.L.C.)

6907 (TID-7619(p.45-56)) THE WATER-MODERATED ASSEMBLY. Harold Lurie (California Inst. of Tech., Pasadena).

A brief review is presented on the use of water-moderated subcritical assemblies in schools. A survey revealed that 74 U.S. schools owned facilities of this type, and it was found that the maximum quantities of fuel and source material loanable by AEC had a restrictive influence on the design of these assemblies. The various types of experiments which may be performed with these assemblies are described, and it is concluded that this type assembly is best suited for routine experiments, although the addition of a pulsed neutron generator would increase its research capability. Two Soviet papers which give original applications of this type assembly are discussed. (D.L.C.)

6908 (TID-7619(p.57-72)) THE GRAPHITE-MODERATED SUBCRITICAL ASSEMBLY. Albert L. Babb (Washington, Univ., Seattle).

Characteristics are summarized for the 13 graphite-moderated subcritical assemblies now in use in U.S. schools. Experimental methods and various experiments which may be run in this type assembly are described. A bibliography of 60 references is given, and a group discussion is included at the end of the paper on both graphite-moderated and water-moderated subcritical assemblies. (D.L.C.)

6909 (TID-7619(p.73-9)) A HETEROGENEOUS ENRICHED ASSEMBLY. F. J. Jankowski (Rutgers Univ., New Brunswick, N. J.).

A subcritical reactor was built at Rutgers Univ., using Al-clad fuel plates of 20% enriched U–Al alloy and a water moderator. The loading is 1.5 kg U^{235}, and the total core weight is 100 lb. Criticality calculations were made and applied in the hazard analyses. Possible uses of the graphite pedestal are discussed. Experiments to be made with the reactor and the reactor construction cost are described. (D.L.C.)

6910 (TID-7619(p.80-8)) A HOMOGENEOUS ENRICHED ASSEMBLY. Robert N. Little (Texas. Univ., Austin).

A cylindrical, homogeneous subcritical assembly was constructed for undergraduate instruction at Texas Univ., using a homogeneous solid mixture of polyethylene and UO_2 with ~20% U^{235} enrichment. The cylindrical core is 14 in. long and 10 in. dia., with a hole for a neutron source or an accelerator target. Experimental measurements of the neutron flux distributions in the assembly are reported. A group discussion is presented on enriched subcritical assemblies. (D.L.C.)

6911 (TID-7619(p.89-108)) A UNIQUE SUBCRITICAL REACTOR-SIGMA PILE. Forrest J. Remick (Pennsylvania State Univ., University Park).

A subcritical reactor-sigma pile combination which is readily converted to one or the other was built at Univ. of Pennsylvania. It is of the graphite-natural uranium type and is placed on its side with the pedestal forming one end of the assembly. As a subcritical reactor, five lattices with $k_\infty > 1$ are available. A typical student experiment conducted with the sigma pile is described. (D.L.C.)

6912 (TID-7619(p.109-22)) THE SMALL COLLEGE AND THE NEUTRON HOWITZER. Richard T. Mara (Gettysburg Coll., Penna.).

The use of a neutron howitzer in a nuclear physics laboratory course is described. Some of the experiments which can be conducted with the howitzer are described and typical data and results given. A group discussion is included in which remarks were made on AEC assistance to small colleges. (D.L.C.)

6913 (TID-7619(p.123-37)) REACTOR SIMULATORS AND COMPUTERS. Warren Fenton Stubbins (Cincinnati. Univ.).

The application of reactor simulators and analog computers in the study of nuclear problems is discussed with a description of reactor simulators and their use in university nuclear programs. The use of analog computers in reactor studies and for other nuclear devices is discussed. The development of a thermal-diffusion simulator in which heat is used as an analog to thermal-neutron flux to study the flux distribution in a subcritical, critical, and supercritical reactor assembly is outlined. A group discussion is included with remarks on the advantages of analog computers over reactor simulators and on the sharing of facilities by large and small colleges. (auth)

6914 (TID-7619(p.138-60)) THE TECHNIQUE OF PULSED-NEUTRON SOURCES. Frank A. Valente (Rensselaer Polytechnic Inst., Troy, N. Y.).

A detailed literature survey is presented on the use of pulsed neutrons in nuclear research. The theory of pulsing techniques is discussed; the diffusion equation is solved for both non-multiplying and multiplying media, and the application of pulsing techniques to reactor kinetics is discussed. Elements of experimental methods are given. A bibliography of 40 references and a group discussion are included. (D.L.C.)

6915 (TID-7619(p.161-82)) OSCILLATORY TECHNIQUES IN A SUBCRITICAL ASSEMBLY. Robert E. Uhrig (Florida. Univ., Gainesville).

Preliminary results are reported for two separate investigations on neutron-wave propagation and the statistical fluctuation of neutron flux in a subcritical assembly. Methods are described by which these phenomena can be used to evaluate parameters of nuclear systems. (D.L.C.)

6916 (TID-7619(p.183-203)) SAFETY IN HEALTH PHYSICS. Karl Z. Morgan (Oak Ridge National Lab., Tenn.).

The hazards of ionizing radiation from many sources, principally medical exposure, are discussed extensively

and compared with the occupational exposure of nuclear energy employees. Maximum permissible doses to occupational employees and to the general population as set by the ICRP, NCRP, and FRC are tabulated and criticized. The exposures and accident frequency at ORNL and Hanford are showed to be low compared with the accident frequency in the chemical industry. The training and problems of health physicists are discussed, and film badges and dosimeters for measuring exposure are described briefly. Some of the requirements of a successful health physics program in a reactor program are outlined. A long group discussion is included which discusses topics such as cosmic radiation effects, measurement of low levels, waste disposal, monitoring of neutron sources, and exposure of school students. (D.L.C.)

6917 (TID-7619(p.204-21)) RECENT EXPERIENCE WITH D_2O SUBCRITICAL ASSEMBLIES. W. C. Redman (Argonne National Lab., Ill.).

The characteristics of heavy-water reactors being developed over the world for purposes other than research or production are summarized. Heavy-water exponential assemblies built at Argonne for educational purposes are described in detail, and laboratory experiments which are performed with these assemblies are outlined. Data are given for the characteristics of the 0.9-m exponential assembly. Some of the research possibilities for this type of assembly are explored. (D.L.C.)

6918 (TID-7619(p.222-38)) EXPONENTIAL PILES IN TEACHING AND RESEARCH. E. Wood (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The history and scope of the Hanford exponential program are discussed, and the experimental methods and problems involved are considered. The reactor physics laboratory course jointly sponsored by General Electric and Washington Univ. is described. Some of the differences between research and teaching uses of exponential assemblies are described, and outstanding problems in exponential techniques and possible graduate research programs are discussed. A group discussion on exponential piles is included. (D.L.C.)

6919 (TID-7619(p.239-59)) RESEARCH AND TEACHING USES OF SUBCRITICAL ASSEMBLIES: PANEL DISCUSSION. J. T. Thompson (Massachusetts Inst. of Tech., Cambridge); Herbert Kouts (Brookhaven National Lab., Upton, N. Y.); Glenn Murphy (Iowa. State Univ., Iowa City); Andrew Robeson (Virginia Polytechnic Inst., Blacksburg); William Kerr (Michigan. Univ., Ann Arbor); and David Clark (Cornell Univ., Ithaca, N. Y.).

A discussion is presented on the role of subcritical assemblies in the education of the nuclear engineer or physicist. The purpose of education is discussed from the respective viewpoints of national laboratories and school nuclear engineering departments. Representatives of various schools present their experience and philosophy on subcritical assemblies. The purpose of the AEC education assistance program is elucidated. It is concluded that subcritical assemblies are best suited for training and that its use for research is secondary, although work could be done using different assembly configurations and making parametric surveys. (D.L.C.)

6920 BUCKLING MEASUREMENTS IN URANIUM–DIPHENYL LATTICES. G. B. Zorzoli (CISE, Segrate, Italy). Energia nucleare (Milan), 8: 780(Dec. 1961). (In English)

An experiment is described that yields a positive buckling value for a natural U-diphenyl lattice. It is shown that systematic errors, insufficient measurements, and unfavorable vessel dimensions render the experimental results incorrect. (T.F.H.)

Elementary Particles and Radiations

6921 (JINR-D-785) AN EXPERIMENTAL INVESTIGATION OF CP-INVARIANCE CONSEQUENCES IN K_2^0 DECAYS. M. Kh. Anikina, D. Neagu, E. O. Okonov, N. I. Petrov, A. M. Rosanova, and V. A. Rusakov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1961. 4p.

Analysis of 597 K_2^0 decays detected in a cloud chamber showed no decay into two charged π-mesons. This result, as well as the equality (within the error) of the probability of the leptonic K_2^0 decays with the emission of π^- and π^+ point to the CP-invariance in the decay interaction of neutral K-mesons. Data obtained earlier which showed a noticeable probability of the K_2^0 decays into 3 π also agreed with this conclusion. Among the 597 K_2^0 decays there were found no two-body decay into charged leptons. (auth)

6922 (NP-11214) $K_{\mu 3}$ AND K_{e3} DECAY AND THE NATURE OF STRANGENESS VIOLATING WEAK INTERACTIONS. S. W. Mac Dowell (Rio de Janeiro. Centro Brasileiro de Pesquisas Fisicas). 1961. 19p. (Notas de Fisica Vol. VIII, No. 6, p.121-38).

A theoretical discussion of the spectra of the decay products of $K_{\mu 3}$ and K_{e3} was carried out to obtain information on strangeness violating weak interactions. It is shown that there exists an angular correlation ($dT/d \cos \alpha$) between the direction of the neutrino momentum in the center of mass system of the lepton pair and the direction of the pion. This angular correlation is quadratic in $\cos \alpha$ independently of the structure of the form factors and provides the best means of identification of the type of coupling. Additional information concerning particularly to the form factor structure can be learned from the pion spectrum. A quantitative test, independent of the form factors, of the universality of the muon and electron interaction is suggested. Some quantitative properties of the electron spectrum in K_{e3}-decay, independent of the form factor structure, were established. They are characteristic of the type of coupling. It is shown how one can obtain the form factor from the knowledge of the electron spectrum if there is only one type of interaction. (auth)

6923 (UCRL-9507) ELASTIC SCATTERING OF PI MESONS ON PROTONS IN THE ENERGY REGION 550 TO 1020 MEV (thesis). Calvin D. Wood (California. Univ., Berkeley. Lawrence Radiation Lab.). Oct. 1, 1961. Contract W-7405-Eng-48. 80p.

The differential cross section was measured for elastic scattering of negative π mesons from protons at incident pion kinetic energies of 550, 600, 720, 900, and 1020 Mev. Pions were produced when the Bevatron circulating proton beam struck a copper target. Pions of the requisite momentum were brought to a focus at a liquid hydrogen scattering target by a magnetic system for beam optics. Elastic scattering events were selected from a background of inelastic events by demanding coincidences between pairs of scintillation counters that were placed at the proper kinematical angles to count elastically scattered pions and their corresponding recoil protons. The resulting angular-distribution curves were least-squares fitted with a cosine power series. A study of the coefficients of the power series permitted certain inferences to be made about the angular momentum states contributing to the second and

third maxima in the total π^--p cross section which occur at 600 and 900 Mev, respectively. The 600-Mev peak appears to be due to a D state, with a total J value of $^3/_2$ rather than $^5/_2$. The data at 900 Mev cannot be well explained by a single (F_{5_2}) state in resonance, but rather there is strong evidence for at least D and F waves in superposition. The forward "diffraction" peaking of the angular distribution indicates that absorptive processes may be predominant. (auth)

6924 (UCRL-9886) THE PION-PION CROSS SECTION BY THE CHEW-LOW METHOD (thesis). D. Duane Carmony (California. Univ., Berkeley. Lawrence Radiation Lab.). Oct. 1961. Contract W-7405-Eng-48. 45p.

By the use of the Alvarez 72-inch hydrogen bubble chamber exposed to a 1.25-Bev/c π^+ beam designed by Professor Frank Crawford, a study of the processes $\pi^+ + p \rightarrow p + \pi^+ + \pi^0$ and $\pi^- + p \rightarrow p + \pi^- + \pi^0$ was carried out. All together, 1737 π^+ and 466 π^- events with low momentum transfer to the proton (less than 400 Mev/c) were measured. Evidence was found for a T = J = 1 di-pion resonance of mass 730 Mev and full width at half maximum of 150 Mev (total di-pion energy squared = 29 neutral pion masses squared). The height of the cross section by extrapolation for both the π^+ and π^- data and in the physical region for the π^+ is consistent with $(2J + 1)\ 4\pi\lambda^2$ for a p-wave resonance. Angular distributions were determined in the physical region for the π^+ data. These distributions are strongly dominated by a $\cos^2\theta_{\pi\pi}$ term (s-, d-, and f-wave resonances can be ruled out by this experiment). The π^- data do not show the dominance of the single-pion exchange process in the physical region. The cross section $\sigma_{\pi^-\pi^0}$ as determined by the Chew-Low extrapolation method does show a resonant rise, thus indicating that the applicability of the Chew-Low method is not restricted to situations in which the physical region contains already as much information as one hopes to learn by extrapolation. (auth)

6925 (UCRL-9919) POLARIZATION OF THE PROTONS FROM HYPERON DECAY (thesis). Edgar F. Beall (California. Univ., Berkeley. Lawrence Radiation Lab.). Oct. 20, 1961. Contract W-7405-eng-48. 59p.

The polarization of the protons from the decays $\Sigma^+ \rightarrow p + \pi^0$ and $\Lambda \rightarrow p + \pi^-$ was studied, a hyperon being produced by the reaction $\pi^+ + p \rightarrow \Sigma^+ + K^+$ in hydrogen, or the reaction $\pi^+ + n \rightarrow \Lambda + K^+$ in lithium deuteride. The polarization of the protons was measured by using a spark chamber with carbon plates. The rare production reactions were separated from the background by using counter techniques based on the stopping and the decay of the K^+ mesons. Kinematics based on measurements of the K^+ and proton directions, and the proton range, were used to further define the events. The asymmetry parameters for the decays under consideration were determined by the maximum-likelihood method. The results for Σ^+ decay are $\alpha_0 = +\ 0.73^{+0.16}_{-0.11}$, $\beta_0 = -\ 0.29^{+1.01}_{-0.45}$, and $\gamma_0 = -\ 0.61^{+1.32}_{-0.14}$. It is shown that these errors are decreased if time-reversal invariance is assumed to be valid. The results for Λ decay are indicative of positive γ_Λ and of negative α_Λ. (auth)

6926 (AEC-tr-4935) PRODUCTION OF POLARIZED PROTONS. F. Duimio, A. Luccio, and C. Succi (Italy. Comitato Nazionale per le Ricerche Nucleari. Centro di Studi Nucleari, Ispra). Translated from report CNI-35. Sept. 1960. 61p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 15, abstract no. 20054.

6927 (NP-tr-836) SCATTERING OF π^- MESONS OF 7-8 GeV ENERGY ON NUCLEONS, WITH LARGE MOMENTUM TRANSFERS. R. A. Aripov, V. G. Grishin, L. V. Sil'vestrov, and V. N. Strel'tsov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). Translated by B. Zacharov from report JINR-P-765. 1961. 4p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 16, abstract no. 4689.

6928 ON THE ELECTROMAGNETIC POTENTIALS OF AN ELECTROMAGNETIC DIPOLE IN MOTION. A. Białas (Jagellonian Univ., Krakow). Acta Phys. Polon., 20: 831-44(1961). (In English)

Starting from the Lorentz solutions of Maxwell's equations, expressions are derived for the electromagnetic potentials of an electromagnetic dipole in arbitrary motion. By utilizing Dirac's δ function in the description of the field sources, these expressions are generalized to multipoles of arbitrary order. For a multipole at rest, they become identical in the wave zone with the well-known formulas for multipole radiation despite the fact that the time dependence of the multipole moments is widely arbitrary. (auth)

6929 SCATTERING OF 14-Mev NEUTRONS BY PROTONS. J. Catalá, M. de la Cuadra, R. Font, J. Aguilar, J. Casanova, and F. Senent (Facultad de Ciencias, Valencia). Anales real soc. españ. fís. y quím. (Madrid), Ser. A, 57: 49-50(Mar.-Apr. 1961). (In Spanish)

Proton-neutron scattering at 14 Mev is studied with neutrons from the $T^3(d,n)He^4$ reaction. The photographic method is used and it is found that the scattering is slightly anisotropic in the center of mass system. (auth)

6930 THE SPIN BEHAVIOR OF DIRAC PARTICLES IN SCATTERING PROCESSES. A. A. Sokolov (Sokolow) (Moscow State Univ.). Ann. Physik (7) 8: 237-59(1961). (In German)

The behavior of the four components of a generalized spin pseudovector, which was commuted with the Hamilton operator, was investigated. An operator expression for a three-dimensional unit pseudovector of the spin was given. This operator was also commutated with the Hamilton operator. It was shown that the direction of the spin pseudovector was indeterminate and actually describes the rotation direction of the circular polarization in a plane, which lies perpendicular to this direction. The transverse component of the spin pseudovector, and not the longitudinal component, was abridged in a Lorentz transformation. In contrast to the theory of Lee and Yang and to the Landau theory, it was shown that in a spatial reflection no asymmetry properties of the space appear (on the basis of the alleged transformation of a right-hand particle into a left-hand particle) and therefore in this transformation the spirality, that is the rotation direction of the polarization relative to the pulse direction, must be maintained and only the mathematical form of its description was changed. If the phenomena of parity nonconservation occurred, which was predicted by Lee and Yang, then it can be explained simply on the basis of the polarization properties of the particle. By an example of elastic scattering it was shown that in the interaction of particles with disappearing rest mass, the spirality was maintained only in vector and pseudovector coupling. Since the parity nonconservation is connected with the polarization properties of the particle, it must occur only in processes in which the neutrino participates. For example, one must be able to observe a phenomenon, which is similar to parity non-conservation, in the study of the polarization properties of synchrotron radiation, in the scattering of longitudinally polarized photons

on polarized electrons, and in the longitudinally polarized electrons emitted in bremsstrahlung. (tr-auth)

6931 IONIZATION AND ENERGY LOSS OF α PARTICLES IN VARIOUS GASES. W. Riezler and H. Schepers (Universität, Bonn). Ann. Physik (7), 8: 270-7(1961). (In German)

The Bragg curve and the glow equivalent weight was measured with ThC' α particles (8.78 Mev) as a function of energy for air, He, Ne, Ar, Kr, Xe, H_2, N_2, O_2, CO, CO_2, CH_4, C_2H_6, C_3H_8, and C_4H_{10}. From the results the following values were determined: extrapolated and mean range, mean relative stopping power, relative stopping power as function of the residual range in air, the magnitudes I occurring in the Bethe formula (mean excitation potential), the energy-range relationship, and the energy loss $\underline{dE}/\underline{dR}$ as a function of the residual range in air. The measurements have shown that in molecular gases, including hydrocarbons, at energies of about 4 Mev and up, the stopping power can be put together additively from the atomic stopping power of the atoms. (tr-auth)

6932 ESTIMATE OF THE POSSIBILITY FOR A $\overline{K}$ – Λ COMPOUND. O. Brulin and B. E. Laurent (Univ. of Stockholm). Arkiv Fysik, 20: 383-7(1961). (In English)

An investigation of the possibility that $(\overline{K},\Lambda)$ compounds are formed as a result of interactions is conducted. A static potential in a nonrelativistic two-particle Schroedinger equation is used. When the intermediate particle is a nucleon, an exchange potential changing the boson K^- to the fermion Λ and vice versa is obtained. An attractive potential in states with odd orbital angular momentum is found. The sign of the potential is changed if the angular momentum is taken to be even or if the interaction is taken to be scalar. The mass of the ground state is found to be equal to the Ξ mass if the coupling constant is chosen so that $G^2/4\pi = 4$ in the scalar and $G^2/4\pi = 10$ in the pseudoscalar case. (L.N.N.)

6933 APPLICATION OF THE METHOD OF MAXIMUM LIKELIHOOD TO THE ESTIMATION OF THE ANGLES BETWEEN CHARGED PARTICLE TRAJECTORIES IN BUBBLE CHAMBERS. Marcel Huybrechts (Institut Interuniversitaire des Sciences Nucléaires, Brussels). Bull. classe sci., Acad. roy. Belg., (5) 47: 515-26(1961). (In French)

The method of maximum likelihood is used in the estimation of the angular coefficient of the tangent to a charged particle trajectory in a bubble chamber, given the coordinates of approximately equidistant points. A weighted average, whose weights are calculated as functions of parameter expressing the relative importance of multiple scattering and measurement errors, is thus obtained as an estimator. The variance of this estimator is calculated and compared with the variances of very simple weighted averages. (tr-auth)

6934 APPLICATION OF THE CENTER-OF-GRAVITY METHOD TO THE DETERMINATION OF THE MULTIPLE SCATTERING TRACKS OF PROTONS OF 27 Bev ENERGY, PRODUCED IN A NUCLEAR EMULSION BY THE CERN SYNCHROTRON. Brigitte Dépaux, Jeanne-Marie Habaru, and Tsai-Chü (Laboratoire de Physique-Enseignement, [Paris]). Compt. rend., 253: 1431-3(Oct. 2, 1961). (In French)

Parasitic diffusion, determined by means of the center-of-gravity method, increases according to the 1.02 ± 0.03 power of the cell length. The mean energy of the protons thus measured is 26.3 ± 1.7 Bev. (tr-auth)

6935 NON-MESON DISINTEGRATION OF TWO HYPERFRAGMENTS. German Baumann, Henri Braun, and Pierre Cüer. Compt. rend., 253: 1434-5(Oct. 2, 1961). (In French)

Two new nonmeson decay modes of ${}_{\Lambda}Be^{8}$ and ${}_{\Lambda}Be^{11}$ hyperfragments created by protons of 24.8 Bev/c in emulsions are described. (tr-auth)

6936 STUDY OF THE EMISSION OF "MARTEAU" TRACKS IN THE INTERACTIONS OF PROTONS OF 24.8 BEV/c WITH THE NUCLEI OF THE IONOGRAPHIC EMULSION. Henri Braun, Germain Baumann, and Pierre Cüer. Compt. rend., 253: 1559-61(Oct. 9, 1961). (In French)

Distribution curves are given for the number of fragments as a function of N_h and N_g, fragment energy, and the angular distribution of 700 "marteau" tracks. The angular distribution has a maximum near 90°, which contradicts the evaporation theory. The energy distribution indicates a number of fragments with higher energy than predicted by this theory. (tr-auth)

6937 THEORETICAL STUDY OF TWO-PHOTON PRODUCTION BY THE COMPTON EFFECT. Guy Burdet and Monique Maitrot (Institut de Physique Nucléaire, Lyon). Compt. rend., 253: 2677-8(Dec. 4, 1961). (In French)

The two-photon production cross section in the Compton effect (i.e., the double Compton effect) is established by the use of quantum electrodynamics. The method used permits the polarization state of the scattered photons to be studied. (tr-auth)

6938 THE NEUTRINO AND ANTINEUTRINO IN FREE SPACE. V. M. Kharitonov (Inst. of Physics, Armenian SSR). Doklady Akad. Nauk S.S.S.R., 141: 66-9(Nov. 1, 1961). (In Russian)

The cross-section σ_0 for slow antineutrinos in the reaction $p + \tilde{\nu} \rightarrow n + e^+$ has been found to be $\sigma_0 = 1.1 \times 10^{-43}$ cm^2. Thus, the universe is practically transparent to neutrinos and antineutrons, since a path of about 10^{28} light years would be required to obtain a single interaction at an average density of 10^{-3} to 10^{-4} atoms of hydrogen per 1 cm^3. With the generation of antineutrinos from an initial cloud of neutrons, the number of antineutrinos (and of neutrinos in the case of world symmetry) is proportional to the density of matter in the universe and is: $n_{\tilde{\nu}} \cong 3 \times 10^5$ [(1 to 10) Δg + (1 to 10)] cm^{-2} sec^{-1}. The first term refers to stellar matter and the second to intergalactic matter. The term Δ_g is the average number of galaxies in a cube 10^6 light years on a side ($\Delta_g \approx 0.1$ to 3). With a constant period of emission of radiation, the accumulated neutrino flux is: $n_{\Sigma\tilde{\nu}} \cong 2$ (10^{-5} to 10^{-6})Δ_g T, where T is the age of the universe in years. The existence of antiworlds and the age of the universe can be verified by measuring the antineutrino flux. The number of fast neutrinos and antineutrinos generated by cosmic rays is estimated as $N_{\nu,\tilde{\nu}} \cong 3$ (10^{-11} to 10^{-14}) kT, where k is the average number of neutrinos or antineutrinos formed per spallation reaction. With a long time of accumulation $N_{\Sigma\tilde{\nu}} \sim 10^4$ cm^2 sec^{-1}, and at $\sigma = 10^{-40}$ cm^2 the antineutrino flux can be determined with a detector having a volume of a few cubic meters at a count rate of ~ 1 to 5×10^{-2} counts per day. Detection of the antineutrino will depend on the following reactions: $p + \tilde{\nu} \rightarrow n + e^+$, and $e^+ + e^- \rightarrow 2\gamma$. A large Cherenkov counter can be set up underground at a depth of 20 to 30 meters, and only positrons originating from antineutrinos passing entirely through the earth are counted (the probability of absorbing an antineutrino passing through the earth is $\sim 10^{-7}$ to 10^{-8}). Information on neutrino and antineutrino fluxes would be valuable in the interpretation of stellar dynamics. (TTT)

6939 DIFFRACTION SCATTERING OF 24-BEV PROTONS AT VERY SMALL ANGLES. G. B. Cvijanovich

(Universität, Bern). Helv. Phys. Acta, 34: 464-5(1961). (In French)

The diffraction scattering of 24-Bev protons was measured around the beam axis at angles between 0 and 6°. In the first series of experiments an emulsion was used as the scatterer, and in the other experiments polyethylene, graphite, or lead was used. The experimental results indicate that the optical model of the proton as a simple absorbent disc is not satisfactory. A modification by adapting an exterior absorbing ring, that is a proton model with a "hard core" surrounded by an absorbing layer, is proposed. Utilization of the Bethe model in analyzing elastic scattering on carbon nuclei shows that the real part of the amplitude of nuclear diffusion is not negligible. (J.S.R.)

6940 ANNIHILATION IN FLIGHT AND BREMSSTRAHLUNG OF 650-MEV POSITRONS IN PROPANE. E. Malamud (Ecole Polytechnique de l'Université, Lausanne, Switzerland), R. Weill, and J. G. McEwen. Helv. Phys. Acta, 34: 497-500(1961). (In French)

A bubble chamber study was made of the in-flight annihilation and bremsstrahlung of positrons in propane. The annihilation cross section was determined, and the results indicated the existence of a radiation correction. Only the emission of high-energy photons was considered, that is those for which $\underline{v} > 0.90$, with $\underline{v} = k/E_0$, where k is the photon energy and E_0 is the energy of the primary positron. The experimental and theoretical values for the bremsstrahlung cross sections for $\underline{v}$ between 0.90 and 1.00 were tabulated. (J.S.R.)

6941 ON A COMPOSITE MODEL OF PION. H. Banerjee (Institut de Physique Théorique, Geneva). Helv. Phys. Acta, 34: 501-2(1961). (In English)

In the theory of nucleons and mesons recently developed by Nambu and Jona-Lasinio (Phys. Rev. 122, 345(1961)), a basic Lagrangian, which was invariant under γ_5-gauge transformation, was used. The invariance of the Lagrangian under the γ_5-gauge group together with the self-consistency condition seems to guarantee the vanishing of the pion mass in the first approximation. The relevance of the requirement of invariance of the Lagrangian under γ_5-gauge transformation was investigated with regard to the vanishing of the pion mass and the divergenceless expectation value of the axial vector current. From the equations derived it is apparent that the expectation value is of the exact form required by the conservation of axial vector current provided the mass of the pion is zero. This is valid even if the Lagrangian is not invariant under γ_5-gauge transformation. (J.S.R.)

6942 DETERMINATION OF THE ENERGY DEPENDENCE OF THE MASS FLUCTUATION COEFFICIENTS OF β RADIATION WITH DEFINITE GEOMETRY IN VACUUM. M. Leistner (Institut für Angewandte Radioaktivität, Leipzig). Kernenergie, 4: 693-6(Sept. 1961). (In German)

The mass fluctuation coefficient can be described by the equation $\mu = 0.022\ E_{max}^{-1.33}$ (E_{max} is the maximum energy of the β radiation). Previous determinations were compiled, and the reasons for the different results were discussed. The apparatus with which the new determination was carried out can also be simultaneously used for absolute determination by the method of definite geometry. (tr-auth)

6943 EXPERIMENTS ON THE POSSIBLE EXISTENCE OF A BOUND DI-NEUTRON. Masakatsu Sakisaka and Michio Tomita (Kōnon Univ., Kōbe, Japan). J. Phys. Soc. Japan, 16: 2597-8(Dec. 1961). (In English)

Phenomena supporting the possible existence of di-neutrons are reported. A tritium-titanium target was bombarded by a deuteron beam at 160 to 185 kev, and the emitted neutrons were moderated. An aluminum-foil sandwiched plastic scintillator, covered by a 1-mm cadmium plate, was placed 12.5 to 27.5 cm from the target and aluminum activities were counted. Half lives of 6.6 ± 0.3 min were detected, and anomalous effects were measured. The anomalous neutron flux decreased more gradually in paraffin than in water; flux distributions of ordinary neutrons were nearly equal in both moderators. The anomalous neutrons were not detected in d + d neutrons (E_d = 170 kev); an increase of anomalous neutrons was observed in lead placed near the target and irradiated by ~14-Mev neutrons. These results are explained, assuming the anomalous neutrons to be di-neutrons. (L.N.N.)

6944 DENSITY MODULATED GROUND STATES IN A GAS OF INTERACTING FERMIONS. E. Werner (Universität des Saarlandes, Saarbrücken, Ger.). Nuclear Phys., 28: 353-68(1961). (In English)

For an infinite system of fermions interacting through a non-local separable potential the question of the existence of density-modulated ground states is investigated in the framework of the independent pair model. It is found that for sufficiently strong interactions or alternatively sufficiently high densities there exist states exhibiting a periodic density variation whose energy is lower than the energy of the states with a homogeneous density distribution. The discussion of the dependence of the effect on the potential strength and the density shows that for nuclear matter the ground state has a uniform density distribution. (auth)

6945 THE MOMENT OF INERTIA OF LARGE SYSTEMS AT FINITE TEMPERATURE. R. E. Prange (Inst. for Advanced Study, Princeton, N. J.). Nuclear Phys., 28: 369-75(1961). (In English)

It is shown, at least for fermion systems, that the moment of inertia of a normal system tends to the classical rigid value as the volume of the system becomes large. A normal system is one for which a long wave length excitation always has low energy, in contrast to the superfluid, for which there is an energy gap. This result is true only at finite temperature. (auth)

6946 THE MOMENT OF INERTIA OF SUPERFLUID FERMION SYSTEMS OF FINITE TEMPERATURE. R. E. Prange (Inst. for Advanced Study, Princeton, N. J.). Nuclear Phys., 28: 376-86(1961). (In English)

The moment of inertia is studied as an example of the second order response of a superfluid to an external force. The theory of Bardeen, Cooper and Schrieffer is used to describe the superfluid. It is essential to use the extension of the theory which maintains gauge invariance. The result shows that the usual two-fluid model is applicable, with the superfluid component governed by the irrotational flow hydrodynamics. A correction is found to the expression for the normal fluid density which takes into account the effective mass of the excitations. (auth)

6947 THE EFFECT OF PAIRING ENERGY ON THE TEMPERATURE EXCITATION ENERGY OF AN INTERACTING FERMION SYSTEM. J. Németh (Eötvös Univ., Budapest). Nuclear Phys., 28: 407-13(1961). (In English)

The excitation energy of an interacting fermion system is calculated as a function of the temperature. The pairing energy gives rise to a basic change in the relation between excitation energy and temperature. This effect may change the level density of a compound nucleus and the expansion and Coulomb barrier of excited nuclei. (auth)

6948 ON THE ANALYSIS OF THE REACTION $\pi^- + p \rightarrow \Lambda^0 + K^0$. R. J. N. Phillips (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nuclear Phys., 28: 519-23(1961). (In English)

A modified partial wave method is suggested, in which K′ and Σ pole terms describe the higher waves. It appears that the s- and p-wave amplitudes must still be found empirically, even fairly close to threshold. (auth)

6949 THE s-WAVE AND p-WAVE STRENGTH FUNCTIONS. T. K. Krueger (Aeronautical Research Lab., Wright-Patterson AFB, Ohio) and B. Margolis. Nuclear Phys., 28: 578-82(1961). (In English)

The s-wave and p-wave neutron strength functions, calculated with an optical model, are compared with experiments for spherical nuclei. The real potential is diffuse and has a spin-orbit term. The imaginary potential is surface-peaked. This surface-peaking produces experimentally—required low strength functions between resonances. A detailed fit to the p-wave strength functions required parameters considerably different from those required to explain other data. (auth)

6950 INTERACTION THEORY IN A NEW ISOBARIC SPIN SPACE. Pierre Hillion and Jean-Pierre Vigier (Institut Henri Poincaré, Paris). Nuclear Phys., 28: 624-35 (1961). (In English)

Utiyama's theory of interactions is extended to an isobaric spin space invariant under the group R_3^* of three-dimensional complex rotations. Utiyama's formalism rests on the utilization of certain simple invariance groups of the Lagrangian, which turn out to be R_2 and R_3 (two-dimensional and three-dimensional real rotation groups). These groups are found to be determined by the invariance properties of the Hilbert space built out of the representations of R_3^*, in which the basic "elementary" fields were defined. The group R_2 is associated with charge conservation, while R_3 yields the conservation of isobaric spin and strangeness. The conservation of baryon number is automatically given by the special form of the baryon fields. The group R_2 introduces the electromagnetic field; R_3 introduces "complexes" of pion-fields and one justifies the $\Delta I = \frac{1}{2}$ selection rule. The theory shows moreover that only strangeness singlets which eliminate all fields belonging to the $D(0,1)$, $D(1,\frac{1}{2})$, and $D(\frac{1}{2},1)$ representations of R_3^* are found which were not observed experimentally. The difference between Σ^0 and Λ^0 in the new space can also be explained. (auth)

6951 COMPTON SCATTERING BY K-SHELL ELECTRONS. J. W. Mortz and G. Missoni (Istituto Superiore di Sanità, Rome). Phys. Rev., 124: 1458-68(Dec. 1, 1961).

The differential cross section $d\sigma_K$ for the Compton scattering of 660-kev photons by the K-shell electrons of tin and gold, is determined by an experimental method in which a scattered photon is selected in coincidence with an accompanying K x ray. This cross section is compared with the Klein-Nishina cross section $d\sigma_F$ for an electron initially free and at rest. The results show that the ratio $d\sigma_K/d\sigma_F$ approaches zero as the photon scattering angle decreases to zero. This behavior agrees qualitatively with the small angle behavior predicted by exact nonrelativistic calculations for the hydrogen atom. For large angles, this ratio is greater than unity and at 110 degrees is equal to approximately 1.2 for tin and 1.4 for gold. The experimental values for $d\sigma_K$ at large angles agree with the theoretical values for the Compton cross section (averaged over the angle between the incident photon and electron) for electrons initially free but with velocities corresponding to the K-shell binding energy. Also, the results indicate that the small- and large-angle behavior for $d\sigma_K$ has a compensating effect in which the ratio of the total cross section σ_K/σ_F (integrated over the photon scattering angle) is approximately equal to unity for both tin and gold. (auth)

6952 ELECTRON SCATTERING FROM HYDROGEN. Charles Schwartz (Univ. of California, Berkeley). Phys. Rev., 124: 1468-71(Dec. 1, 1961).

Kohn's variational principle was used to calculate S-wave elastic scattering of electrons from atomic hydrogen, using up to 50 trial functions of the type introduced by Hylleraas to describe the bound states of two-electron atoms. The phase shifts calculated at several energies up to 10 ev apparently converged well, leaving residual uncertainties mostly less than one thousandth of a radian. Including the effect of the long-range force at zero energy, accurate values for the scattering lengths were obtained. (auth)

6953 REVISED CALCULATIONS ON THE PHOTODISINTEGRATION OF THE DEUTERON. W. Zickendraht, D. J. Andrews, M. L. Rustgi, W. Zernik, A. J. Torruella, and G. Breit (Yale Univ., New Haven). Phys. Rev., 124: 1538-40(Dec. 1, 1961).

A numerical error which affected results in two of the approximations reported on previously is taken into account. Revised values of coefficients for formulas and graphs illustrating typical effects of the revision are supplied. The disagreement with experiment at the smaller proton angles and higher energies is accentuated while agreement with experiment at the lower energies and larger as well as smaller angles is, on the whole, improved and is practically unaffected at the lower energies and higher angles. (auth)

6954 MULTIPLE PION PRODUCTION BY PIONS AND THE ISOBAR MODEL. V. P. Kenney, J. G. Dardis, and G. Brunhart (Univ. of Kentucky, Lexington). Phys. Rev., 124: 1568-74(Dec. 1, 1961).

Multiple pion production by pions in hydrogen was studied in the interaction $\pi^- + p \rightarrow p + \pi^- + \pi^+ + \pi^-$ at 810, 970, and 1100 Mev. Total cross sections were measured as 0.26 ± 0.14 mb at 810, 0.32 ± 0.21 mb at 970, and 0.54 ± 0.32 mb at 1100 Mev. The kinematics of this pion production reaction at these energies appear to be reasonably well described by phase space dependence, but provide some support for an "isobar cascade" scheme in which the $T = \frac{1}{2}$ "second resonance" is excited and decays to the $T = J = \frac{3}{2}$ isobar, which decays in turn to a final state consisting of a nucleon, a recoil pion, and two decay pions. (auth)

6955 ELECTRON-POSITRON COLLIDING BEAM EXPERIMENTS. N. Cabibbo and R. Gatto (Università, Rome and Cagliari, Italy and C.N.E.N., Frascati, Italy and Rome). Phys. Rev., 124: 1577-95(Dec. 1, 1961).

Possible experiments with high-energy colliding beams of electrons and positrons are discussed. The role of the proposed two-pion resonance and of the three-pion resonance and of the three-pion resonance or bound state is investigated in connection with electron-positron annihilation into pions. The existence of a three-pion bound state would give rise to a very large cross section for annihilation into $\pi^0 + \gamma$. A discussion of the possible resonances is given based on consideration of the relevant widths as compared to the experimental energy resolution. Annihilation into baryon-antibaryon pairs is investigated and polarization effects arising from the nonreal character of the form factors on the absorptive cut are examined. The density matrix for annihilation into pairs of vector mesons

is calculated. A discussion of the limits from unitarity to the annihilation cross sections is given for processes going through the one-photon channel. The cross section for annihilation into pairs of spin-one mesons is rather large. The typical angular correlations at the vector-meson decay are discussed. A neutral weakly interacting vector meson would give rise to a strong resonant peak if it is coupled with lepton pairs. Effects of the local weak interactions are also examined. The explicit relation between the e^2 corrections to the photon propagator due to strong interactions and the cross section for annihilation into strongly interacting particles is given. (auth)

6956 MEASUREMENT OF THE NEUTRON-PROTON FINAL-STATE INTERACTION IN THE ELECTRODISINTEGRATION OF DEUTERIUM. H. W. Kendall, J. I. Friedman, E. F. Erickson, and P. A. M. Gram (Stanford Univ., Calif.). Phys. Rev., 124: 1596-1601(Dec. 1, 1961).

Measurements have been made of the inelastic differential cross sections for electrodisintegration of deuterium for ϵ in the range from 0 to 12 Mev, where ϵ is the energy in the n-p center-of-mass system in the final state. Primary electron energies were in the range from 204 to 500 Mev. The process was studied for momentum transfers from 1.8 to 2.8 f^{-1}. The n-p interaction in the unbound state gives rise to a peak in the differential cross sections for ϵ near zero for transitions to the ^1S and ^3S states of the n-p system. The high momentum transfers available make the results sensitive to the short range structure of the unbound n-p wave functions. The results fail to agree with the predictions of Jankus even at the lowest momentum transfers, when a central attractive force is assumed for the n-p force. At the highest momentum transfers the predicted cross sections are approximately 50% greater than the measured ones. The experimental results agree with theory if a repulsive core of the radius required to fit the elastic scattering data is used both in the bound and unbound n-p states. The extent to which relativistic corrections alter this conclusion is not known at present. (auth)

6957 ELECTROMAGNETIC FORM FACTORS OF THE PROTON. F. Bumiller, M. Croissiaux, E. Dally, and R. Hofstadter (Stanford Univ., Calif.). Phys. Rev., 124: 1623-31(Dec. 1, 1961).

Experimental findings on the Dirac (F_1) and Pauli (F_2) form factors of the proton are reported. The form factors were obtained by using the Rosenbluth formula and the method of intersecting ellipses in analyzing the elastic electron-proton scattering cross sections. A range of energies covering the interval 200 to 1000 Mev for the incident electrons is explored. Scattering angles vary from 35° to 145°. Values as high as $q^2 \cong 31\ f^{-2}$ (q = energy-momentum transfer) are investigated, but form factors can be reliably determined only up to about $q^2 = 25\ f^{-2}$. Splitting of the form factors is confirmed. The newly measured data are in good agreement with earlier Stanford data on the form factors and also with the predictions of a recent theoretical model of the proton. Consistency in determining the values of the form factors at different energies and angles gives support to the techniques of quantum electrodynamics up to $q^2 \cong 25\ f^{-2}$. At the extreme conditions of this experiment (975 Mev, 145°) the behavior of the form factors may be exhibiting some anomaly. (auth)

6958 DISPERSION RELATIONS FOR PRODUCTION AMPLITUDES. [PART] II. Y. S. Kim (Princeton Univ., N. J.). Phys. Rev., 124: 1632-8(Dec. 1, 1961).

The question of single-variable dispersion relation is discussed in the framework of perturbation theory, for the production reactions: $\gamma + N \rightarrow \gamma + \pi + N$, $\pi + N \rightarrow \gamma + \gamma + N$, and $\pi + N \rightarrow \gamma + \pi + N$. It is shown that the contributions from single-loop diagrams satisfy the dispersion relation which was conjectured by Logunov et al. The discussion is extended to higher orders. The amplitude associated with a certain class of diagrams are shown to satisfy the cut plane representation. For the rest of the diagrams, a plausibility argument is given. (auth)

6959 RELATIVISTIC SCHRÖDINGER'S EQUATION FOR THE TWO-NUCLEON SYSTEM. Suraj N. Gupta (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 124: 1638-40(Dec. 1, 1961). (BNL-5570)

The relationship between the relativistic and nonrelativistic forms of Schrödinger's equation for two nucleons in their center-of-mass system is investigated, and the velocity dependence of the relativistic one-pion exchange nuclear potential is discussed. (auth)

6960 SECONDARY ELECTRON PRODUCTION FROM METALS BY 1-MEV PROTONS. S. Kronenberg, K. Nilson, and M. Basso (Army Signal Research and Development Lab., Fort Monmouth, N. J.). Phys. Rev., 124: 1709-12(Dec. 15, 1961).

Be, Al, Cu, and Au targets were bombarded with 1-Mev protons. The resulting secondary electrons were investigated in respect to their intensity, energy distribution, and energy distribution as a function of angle of emission. The results show that, contrary to previous investigations, electrons with energies higher than those corresponding to the so-called local-heating effect contribute considerably to the total yield. About 75% of the secondaries are emitted at low energies, and the remaining part is emitted with high energies (up to 2000 ev for 1-Mev protons). The electron spectrum decreases rapidly toward the high-energy end. The high-energy component is not emitted isotropically, but preferably backwards in the direction from which the protons arrive. (auth)

6961 SINGLE-QUANTUM ANNIHILATION OF POSITRONS. L. Sodickson, W. Bowman, J. Stephenson (Massachusetts Inst. of Tech., Cambridge) and R. Weinstein. Phys. Rev., 124: 1851-61(Dec. 15, 1961).

An experiment was performed to investigate single-quantum annihilation of positrons in the field of high-Z nuclei. This mode of annihilation was observed and the absolute magnitude, energy dependence, and Z dependence of the cross section measured. Backgrounds which might contaminate the derived signals were semiempirically investigated and found to be an order of magnitude or more below the rate identified as single-quantum annihilation. The data on absolute magnitude of the counting rate and its dependence on positron energy agree with previous calculations of others. The Z dependence agrees with a cross section proportional to Z^5. (auth)

6962 ATTEMPT TO DETERMINE THE n-n SCATTERING LENGTH FROM THE REACTION D(n,p)2n. K. Ilakovac, L. G. Kuo, M. Petravić, and I. Šlaus (Institute Ruđer Bošković, Zagreb). Phys. Rev., 124: 1923-8 (Dec. 15, 1961).

The high-energy part of the proton spectrum at 4° from the reaction D(n,p)2n at 14.4 Mev was analyzed using the final-state interaction formalism, taking into account only the n−n interaction in the final state. The primary interaction was calculated in a kind of Born approximation. It was shown that the shape of the high-energy part of the proton spectrum is dependent mostly on the n−n scattering length, a_{nn}, and that by varying a_{nn}, a good fit to the shape

of this part of the spectrum is obtained. From this analysis, a value of $a_{nn} = (-22 \pm 2)$f was obtained. However, this value of a_{nn} is to some extent dependent on the accuracy of the approximations used. A more refined theoretical treatment would therefore be desirable. (auth)

6963 CAPTURE OF 14.4-MEV NEUTRONS BY PROTONS AND DEUTERONS. M. Cerineo, K. Ilakovac, I. Šlaus, and P. Tomaš (Institute Ruđjer Bošković, Zagreb). Phys. Rev., 124: 1947-8(Dec. 15, 1961).

A counter telescope in connection with a two-dimensional analyzer was used to determine the ratio of the 14.4-Mev neutron capture and elastic scattering cross sections. The cross section for the capture by protons was determined to be 31.6 ± 3.1 μb. This value is in reasonable agreement with the theoretically predicted value. The cross section for the capture of neutrons by deuterons was found to be 29.4 ± 5.8 μb. (auth)

6964 ENERGY DEPENDENCE AND ABSORPTION IN THE USE OF RECOIL POLARIZATION FROM π-p SCATTERING. Peter B. Shaw (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 124: 1971-4(Dec. 15, 1961).

The use of recoil polarization to determine angular momentum assignments for the second and third resonances in π^--p scattering is found to be qualitatively unaffected by the presence of absorption in the resonant states. The energy dependence of the polarized cross section in the vicinity of a resonance is shown to give some information about both the background and the resonant state. The polarized cross section is expected to increase across a resonance if $L = J + \frac{1}{2}$ and decrease if $L = J - \frac{1}{2}$. (auth)

6965 EFFECT OF THE $(\Lambda - \pi)$ RESONANCE IN INELASTIC NUCLEON-HYPERON COLLISIONS. S. N. Biswas and V. Gupta (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 124: 1974-7(Dec. 15, 1961).

Using an extension of the Chew-Low extrapolation procedure, the $Y + N \rightarrow Y' + N + \pi$ differential cross sections were calculated. The calculation requires a knowledge of the energy dependence of the total pion-hyperon elastic scattering cross sections, for which use was made of the results of Dalitz and Tuan based on the analysis of $\bar{K} - N$ data. The effect of $\Lambda - \pi$ resonance (Y_1^*) in the present processes appears in the strong peaking at low energy and a "knee" at a higher energy in the energy spectrum of the recoil nucleon. In view of the rare strong decay of $Y_1^* \rightarrow \Sigma + \pi$, it is suggested that the reaction $\Lambda + N \rightarrow \Lambda + N + \pi$ would be best suited for experimental study. (auth)

6966 π^- p INTERACTIONS AT 224 MEV. J. Deahl, M. Derrick, J. Fetkovich, T. Fields, and G. B. Yodh (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 124: 1987-94(Dec. 15, 1961).

Interactions of 224-Mev negative pions with protons were investigated using a 15-cm hydrogen bubble chamber in a 13-kgauss field. Seventeen hundred elastic scatterings were analyzed yielding a cross section of 16.0 ± 0.8 mb for this process. No evidence for powers of $\cos\theta$ higher than two was observed in the angular distribution. The charge-exchange cross section, based on 1200 events was 34.4 ± 1.9 mb. The results of a random-search phase-shift analysis, using these data in conjunction with earlier π^+-p elastic scattering results and recoil proton polarization measurements (π^--p), are reported. A search for pion production yielded three events of the type $\pi^- + p \rightarrow \pi^- + \pi^+ + n$ corresponding to a cross section of ~30 μb. No events of the type $\pi^- + p \rightarrow \pi^- + \pi^0 + p$ were observed. (auth)

6967 POSSIBLE THEORETICAL INTERPRETATIONS OF THE EXCITED HYPERONS. J. Franklin, R. C. King, and S. F. Tuan (Brown Univ., Providence). Phys. Rev., 124: 1995-9(Dec. 15, 1961).

The recently discovered excited hyperons are discussed in terms of four alternative interpretations. These appear to be the only possibilities which are not inconsistent with the current experimental and theoretical situation. Each possibility is analyzed in terms of theoretical models and their experimental consequences summarized. Experiments which would serve to determine which interpretation is correct are discussed. (auth)

6968 THEORY OF THE ELECTRO- AND PHOTOPRODUCTION OF π MESONS. Philippe Dennery CERN, Geneva. Phys. Rev., 124: 2000-10(Dec. 15, 1961).

The scattering amplitude for the electroproduction of pions from nucleons is derived using the Mandelstam representation. It is shown that the amplitude consists mainly of two parts which in the framework of the Cini-Fubini approximation are simply additive. One part describes the effects of a $\pi - \pi$ resonance, while the other part describes the $\frac{3}{2} - \frac{3}{2}$ resonant nucleon term. The theory is fully relativistic in the sense that no expansion in inverse powers of the nucleon mass is made. This means that even though the theory is applicable only in the low-energy region where the $\frac{3}{2} - \frac{3}{2}$ resonance dominates, the momentum transfer variable upon which the various form factors depend, may be very large. The meson-current Born term contains explicitly the form factor of the pion and can be isolated at high momentum transfers to the electrons, where the resonant nucleon term becomes small. (auth)

6969 COUPLING CONSTANT FOR SMALL BINDING ENERGY IN DISPERSION THEORY. Michael Nauenberg (Brookhaven National Lab., Upton, N. Y. and Univ. of California, La Jolla). Phys. Rev., 124: 2011-13(Dec. 15, 1961).

The renormalized coupling constant associated with a bound state and its two composite particles is investigated as a function of binding energy using the N/D method of Chew and Mandelstam. (auth)

6970 ELECTROMAGNETIC PRODUCTION OF PION PAIRS. Clayton D. Zerby (Oak Ridge National Lab., Tenn.). Phys. Rev., 124: 2029-37(Dec. 15, 1961).

The Pauli-Weisskopf theory of pion pair production by photons was modified to include the strong pion-nucleus interaction in the form of a complex optical potential, and the matrix element was obtained by using "exact" distorted plane waves which were expanded into angular momentum eigenstates. Numerical calculations were performed for lead to examine the effect of a nuclear charge distribution and nuclear optical potential on the cross section in the energy region just above threshold. The calculations show that when the charge distribution and nuclear potential are included, the cross section for lead which leaves the nucleus in an unexcited state increases slowly just above threshold until approximately 295 Mev, where it starts to increase almost linearly, attaining a value of 1.07×10^{-32} cm^2 at 310 Mev. (auth)

6971 RADIATIVE MODES OF K-MESON LEPTONIC DECAY. Donald E. Neville (Univ. of Chicago). Phys. Rev., 124: 2037-46(Dev. 15, 1961).

The gamma-ray spectra for the decays $K \rightarrow \mu\nu\gamma$ and $K \rightarrow e\nu\gamma$ as well as $\pi \rightarrow \mu\nu\gamma$ and $\pi \rightarrow e\nu\gamma$ are calculated in full: Terms in the spectra proportional to lepton mass are retained so that the results are applicable to the muon decay mode, and the calculations take into account both inner

Bremsstrahlung radiation and radiation arising from structure in the meson vertex. The latter contributions are expressed in terms of two form factors. The modes $K \to \mu\nu\gamma$ and $K \to e\nu\gamma$ can be used to test the validity of Wigner time-reversal invariance. Two ways of doing this are given, one based on measurements of the gamma spectra and the other on measurements of the transverse polarization of the muons from the $K \to \mu\nu\gamma$ decay. Calculations were carried out on the effect of a possible intermediate vector boson on the decay $K \to e\nu\gamma$. Contributions from internal Bremsstrahlung radiation are given. The strongly interacting intermediate states which give rise to structure-dependent radiation are listed, and a discussion of possible ambiguities, arising from these states, is given. (auth)

6972 LIMIT ON HIGH-ENERGY CROSS SECTION FROM ANALYTICITY IN LEHMANN ELLIPSES. O. W. Greenberg and F. E. Low (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 124: 2047-8 (Dec. 15, 1961).

High-energy limits on the scattering amplitude and the total cross section follow from that analyticity of the scattering amplitude in ellipses in cos $\theta_{c.m.}$ which was proved rigorously by Lehmann, together with unitarity. The limits for the scattering amplitude are $|T| < (\text{const})W^4\ln^2 W$, for the forward and backward directions, and $|T| < (\text{const})W^3\ln^3 W$ for other fixed directions, where W is the total center-of-mass (c.m.) energy. For the total cross section the limit is $\sigma < (\text{const})W^2\ln^2 W$. (auth)

6973 ELASTIC AND INELASTIC SCATTERING OF HIGH-ENERGY PROTONS FROM HYDROGEN. G. Cocconi, A. N. Diddens, E. Lillethun, G. Manning, A. E. Taylor, T. G. Walker, and A. M. Wetherell (CERN, Geneva). Phys. Rev. Letters, 7: 450-4 (Dec. 15, 1961).

Proton elastic and inelastic cross sections for reactions with hydrogen were measured using a CH_2-C difference method, and again with targets in the internal beam of the CERN proton synchrotron. The measurements were made at laboratory scattering angles close to 60 milliradians with incident proton momenta between 12 and 27 Bev/c. Spectral and cross-section data are presented. (L.N.N.)

6974 π-MESON PRODUCTION IN 2.9-Bev p-p COLLISIONS. A. C. Melissinos (Univ. of Rochester, N. Y.), G. G. Fazio, T. Yamanouchi, S. J. Lindenbaum, and L. C. L. Yuan. Phys. Rev. Letters, 7: 454-7 (Dec. 15, 1961).

The momentum spectrum of charged π mesons produced in proton interactions at 2.9 Bev was measured, using counter techniques. Detailed momentum spectra of the π mesons as a function of the angle are provided. The experiment was performed at Brookhaven's Cosmotron using the external proton beam III and a liquid H_2 target. The spectra were measured at 0, 17, and 32° in the laboratory; the circulating beam intensity ranged from 2×10^{10} to 2×10^{11} protons/pulse with 30% extraction efficiency to the second focus. A summary of the integrated cross sections is given and comparison is made with results of the bubble chamber work. Agreement was obtained. The shape of the momentum spectra at various angles, especially 0°, provides a crucial test for the most current theories on π production. (L.N.N.)

6975 EXPERIMENTAL PROOF OF THE SPIN DEPENDENCE OF THE MUON CAPTURE INTERACTION, AND EVIDENCE FOR ITS (F-GT) CHARACTER. G. Culligan (Univ. of Chicago), J. F. Lathrop, V. L. Telegdi, R. Winston, and R. A. Lundy. Phys. Rev. Letters, 7: 458-60 (Dec. 15, 1961).

Observations to determine whether the "universal V-A" interaction, as yet unproved in the case of μ capture, are made qualitatively. The time dependence of the rates at which neutral products (neutrons and/or nuclear photons) are emitted in the capture of muons by F^{19} was measured to determine the spin dependence. A LiF target was used, since lithium has a negligible capture rate. Selection of either γ- or n-induced pulses could be made. Results are presented in tabular form, and comparisons between observed and theoretical parameters are made. Using the precession rate, decay asymmetry parameters of μ^- bound to F^{19} (UF_6 target) and to C^{12} (graphite) are compared. It is concluded that, in general, μ^- capture is spin dependent; for F^{19}, $\Lambda^- > \Lambda^+$ ($A' > 0$); its magnitude is near the maximum possible, i.e., that predicted for an ($F^+ \times GT$) interaction with $x \simeq -1$; both the absolute rates and their spin dependence agree with the "universal V-A" prediction, and exclude a (V + A) interaction; and there is a fast $F^+ \to F^-$ conversion process of the predicted rate. (L.N.N.)

6976 SPIN OF Y_1^*. Robert P. Ely, Sun-Yiu Fung, George Gidal, Yu-Li Pan, Wilson M. Powell, and Howard S. White (Univ. of California, Berkeley). Phys. Rev. Letters, 7: 461-4 (Dec. 15, 1961).

Correlations in the production and decay angular distributions of the Y^* that support $J \geq 3/2$ are presented. Properties of the T = 1 Y^* produced by the interaction of 1.11 ± 0.03 Bev/c K^- mesons in the 30-in. propane bubble chamber at the Bevatron are studied using the reaction $K^- + p \to \Lambda + \pi^+ + \pi^-$. Production angular distributions for Y^{*-} and Y^{*+} events are measured. Decay angular distributions are related to the spin state of the Y^*. Interference effects estimated imply that $J \geq 3/2$, from the observed anisotropy about the production normal; the production angular distribution and the Adair distributions are both consistent with this hypothesis. (L.N.N.)

6977 K^* AND $K^+ - 3\pi$ DECAY. Riazuddin (Panjab Univ., Lahore, Pakistan) and Fayyazuddin. Phys. Rev. Letters, 7: 464-6 (Dec. 15, 1961).

It is shown that the observed deviation of the spectrum of the unlike pion in $K^+_{\pi 3}$ decay from the statistical distribution can be explained via K^- provided that the K^- has spin unity. The spectrum is the same as that presented by S. Weinberg (NSA, 14: 8938) on the basis of the $|\Delta\vec{I}| = 1/2$ rule and is consistent with experiment (NSA, 14: 16227). (L.N.N.)

6978 VECTOR MESONS AND POSSIBLE VIOLATIONS OF CHARGE SYMMETRY IN STRONG INTERACTIONS. Sergio Fubini (Università, Turin and CERN, Geneva). Phys. Rev. Letters, 7: 466-8 (Dec. 15, 1961).

Theoretical implications and experimental consequences of the existence of a neutral meson (Γ) of mass 780 Mev, which can decay both into two pions and three pions, are discussed. It is shown that the size of the charge-symmetry violation induced by the Γ depends upon the role played by the Γ in the different reactions and, in particular, on the manner in which its long lifetime can be reconciled with the large production rate. (L.N.N.)

6979 IS ISOTOPIC SPIN A GOOD QUANTUM NUMBER FOR THE NEW ISOBARS? Sheldon I. Glashow (Stanford Univ., Calif.). Phys. Rev. Letters, 7: 469-70 (Dec. 15, 1961).

Relatively long-lived meson and hyperon isobars display regularities in mass beyond what may be anticipated from known symmetry principles. The three members of the (T = 1, J = 1) 750-Mev two-pion resonance (ρ) differ in mass from the (T = 0, J = 1) 785-Mev three-pion resonance (ω) by 4%; the masses of the T = 1 hyperon isobar at 1385 Mev and the T = 0 hyperon at 1400 Mev differ by about 1%; and the Σ and Λ hyperons show a mass splitting of 7%. It is shown that electromagnetism fails to conserve isotopic spin and that nonradiative transitions may occur. The

closeness of the respective masses may greatly enhance the extent that their decays violate isotopic invariance. Further evidence for these statements is provided. (L.N.N.)

6980 SCALAR NUCLEON FORM FACTOR $F_1^n + F_1^p$. Norman K. Glendenning and Gustav Kramer (Univ. of California, Berkeley). Phys. Rev. Letters, 7: 471-2(Dec. 15, 1961). (UCRL-9905)

Upper and lower limits on the scalar nucleon form factor $F_1^n + F_1^p$ and the neutron form factor F_1^n are deduced from the experimental proton and deuteron form factors F_1^p and G. The proton form factor is obtained by drawing a smooth curve through experimental points (NSA, 15: 9912). (L.N.N.)

6981 ANISOTROPIES IN ANGULAR DISTRIBUTIONS OF MOLECULAR DISSOCIATION PRODUCTS. Gordon H. Dunn (National Bureau of Standards, Washington, D. C.). Phys. Rev. Letters, 8: 62-4(Jan. 15, 1962).

General symmetry arguments giving selection rules and showing that anisotropies are expected in a majority of cases are presented. Discussion is confined to electron scattering by diatomic molecules. (L.N.N.)

6982 POLARIZATION IN NEUTRON–PROTON SCATTERING AT 16 AND 24 Mev. W. Benenson, R. L. Walter, and T. H. May (Univ. of Wisconsin, Madison). Phys. Rev. Letters, 8: 66-7(Jan. 15, 1962).

The polarization was determined from asymmetry measurements in polarized monoenergetic neutron scattering by protons. The neutrons were produced by bombarding a tritium-gas target with deuterons. The scattering was observed by detecting the recoil protons and scattered neutrons in fast coincidence. The proton recoils were produced and detected in a plastic scintillator. Use of a solenoid, which rotated the spin of the incident neutrons, and two symmetric neutron counters reduced asymmetries caused by misalignment and variation in the neutron flux. Data are presented in tabular form. (L.N.N.)

6983 SIGNIFICANCE OF NEUTRON–PROTON POLARIZATION MEASUREMENTS IN THE 20-MEV ENERGY RANGE. M. H. Hull, Jr., F. A. McDonald, H. M. Ruppel, and G. Breit (Yale Univ., New Haven). Phys. Rev. Letters, 8: 68-70(Jan. 15, 1962).

Neutron-proton polarizations were calculated theoretically and observed experimentally at 16 and 24 Mev. It was found that combinations of parameters determining proton-proton polarization enter the calculations. The validity of charge independence is assumed by the employment of T = 1 phase parameters determined from p-p scattering in the analysis of n-p scattering data. Effects of magnetic scattering are negligible. (L.N.N.)

6984 NEUTRAL PION PRODUCTION BY 960-Mev NEGATIVE PIONS. A. Weinberg, A. E. Brenner, and K. Strauch (Harvard Univ., Cambridge, Mass.). Phys. Rev. Letters, 8: 70-2(Jan. 15, 1962).

Using a 1.14-Bev/c π^- beam, a study was made of π^0 production in the reactions $\pi^- + p \rightarrow \pi^0 + n$, $\rightarrow 2\pi^0 + n$, and $\rightarrow 3\pi^0 + n$. Differential cross sections, necessary in order to analyze the $T = \frac{1}{2}$ $N - \pi^-$ interaction, are reported for $\pi^- + p \rightarrow \pi^0 + n$. Integral cross sections are given for all three reactions. (L.N.N.)

6985 DIFFERENTIAL $\pi-\pi$ CROSS SECTIONS: EVIDENCE FOR THE SPIN OF THE ρ MESON. D. Duane Carmony and Remy T. Van de Walle (Univ. of California, Berkeley). Phys. Rev. Letters, 8: 73-5(Jan. 15, 1962).

Data on the reaction $\pi^+ + p \rightarrow \pi^+ + p + \pi^0$ are reported. The data consist of a sample of 1684 events in which the proton recoiled at a momentum between 100 and 400 Mev/c. Existence of a $\pi-\pi$ resonance at a total mass of ~725 Mev is confirmed both by the extrapolation method and by using physical-region plots. Exploitation of the dominance of the $\pi-\pi$ resonance effect in the physical region produces direct evidence, through angular distributions, that the resonance has spin 1. (L.N.N.)

6986 HYPERON DECAY PARAMETERS AND THE KΛN PARITY. E. F. Beall, Bruce Cork, D. Keefe, P. G. Murphy, and W. A. Wenzel (Univ. of California, Berkeley). Phys. Rev. Letters, 8: 75-8(Jan. 15, 1962).

It is shown that a determination of KΛN parity may, under certain assumptions, be obtained by measuring the s wave to p wave amplitudes in the decay $\Lambda \rightarrow p + \pi^-$. Measurements are reported, and results on parameters for the decays $\Sigma^+ \rightarrow p + \pi^0$ and $\Lambda \rightarrow p + \pi^-$ are presented and discussed. (L.N.N.)

6987 RARE DECAY MODES OF THE $\omega(\eta)$ MESON. Yoichiro Nambu and J. J. Sakurai (Univ. of Chicago). Phys. Rev. Letters, 8: 79-81(Jan. 15, 1962).

Decay modes of the ω and/or η meson into two charged particles $e^+ + e^-$, $\mu^+ + \mu^-$, or $\pi^+ + \pi^-$ are considered. It is shown that the $\pi^+-\pi^-$ mode of the ω may turn out to be relatively frequent. The ω "rides on" the T = 1, J = 1 $\pi-\pi$ resonance (ρ) peak so that the final-state interaction between the π^+ and π^- in a p-state strongly enhances the $\pi^+-\pi^-$ mode. Quantitatively, partial-decay rates for the e^+-e^- and $\mu^+-\mu^-$ modes are calculated in terms of the coupling constant of the $\omega(\eta)$ meson to the nucleon and the $\omega(\eta)$ meson contribution to the isoscalar charge form factor. Goldberger-Treiman type relations for the $\omega(\eta)$ meson exist. If the $\omega \rightarrow \pi^+ + \pi^-$ mode is unusually enhanced and if the ω width is narrow, a spurious ρ peak at the ω mass may be expected for the $\pi^+-\pi^-$ Q-value distribution but not for the $\pi^+-\pi^0$ Q-value distribution. In spite of their small branching ratios, the leptonic decays might be observable. If ω and/or η are responsible for the form factors, corresponding peaks in the Q-value distribution of e^+-e^- and $\mu^+-\mu^-$ pairs may be expected. (L.N.N.)

6988 REMARK ON ENERGY PEAKS IN MESON SYSTEMS. M. Nauenberg (Columbia Univ., New York) and A. Pais. Phys. Rev. Letters, 8: 82-4(Jan. 15, 1962).

By convention, the marked dominance in the peak region of a state with well-defined quantum numbers such as angular momentum, parity, isotopic spin, and hypercharge is called a particle. As a function of energy, the influence of such a state is centered on the peak with a characteristic half-width. The occurrence in meson systems of peaks which, even though sharp, cannot be called particles in the conventional sense is discussed. The effect does not occur in only one angular momentum state. It may, in general, occur at the same energy in more than one isotopic spin state. Finally, the peak has a characteristic asymmetric distribution which cannot be described by a Breit-Wigner formula. Moreover, if the peak occurs in a 3-particle state, there is a characteristic Dalitz-Fabri plot (Phil. Mag. 44, 1068(1953); Nuovo Cimento 11, 479(1954)) associated with it. (L.N.N.)

6989 DEPENDENCE OF PROTON TRACKS ON ENERGY IN NIKFI-Ya2 EMULSION. E. S. Anashkina (Inst. of Physics and Tech., Academy of Sciences, USSR). Pribory i Tekh. Ekspt., 6: No. 4, 148(July-Aug. 1961). (In Russian)

Measurements on NIKFI-Ya2 emulsion density show that $d = 3.474 \pm 0.080$ g/cm^3 at relative humidity 58 to 60%. Measurements were made of recoil proton tracks produced by neutrons from (d,d) and (d,T) reactions. The track lengths were 55.7 ± 2.5 and 1040 ± 50 μ, respectively. The neutron spectra for (d,d) and (d,T) reactions are plotted. (R.V.J.)

6990 SEPARATION OF PARTICLES BY RELATIVE INTENSITY OF SLOW COMPONENTS IN STILBENE FLUORESCENCE. V. O. Vyazemskii, K. A. Gridnev, and A. N. Pisarevskii (Radium Inst., Academy of Sciences, USSR). Pribory i Tekh. Eksp., 6: No. 4, 149-50(July-Aug. 1961). (In Russian)

The scheme compares the separated slow component signal with complete scintillation pulses. In the first approximation the fluorescence in stilbene follows an exponential law (the fluorescence times are 7×10^{-9} and 3×10^{-7} sec for fast and slow components). The device was used for separating α particles of Pu^{239} from the ~1-Mev γ background. The counting rate averaged 2×10^4 sec^{-1}. The scheme of the differentiation device and developed oscillograms is included. (R.V.J.)

6991 LOW VOLTAGE NEUTRON GENERATORS (REVIEW). E.-G. V. Aleksandrovich and V. A. Sokovishin. Pribory i Tekh. Eksp., 6: No. 5, 7-25(Sept.-Oct. 1961). (In Russian)

A review is given of low-voltage neutron generators. The nuclear reactions occurring in deuterium and tritium interactions and various neutron-producing targets are discussed. Vacuum pumped, vacuum soldered, gas-filled, low-voltage generators and their uses in scientific investigations are considered. Ninety references are included. (R.V.J.)

6992 NEUTRON GENERATOR WITH SPARK ION SOURCE. G. E. Murguliya and A. A. Plyutto. Pribory i Tekh. Eksp., 6: No. 5, 28-30(Sept.-Oct. 1961). (In Russian)

A neutron generator with a spark ion source, producing neutron pulses of ~15 μsec at frequencies up to 50 imp/sec, is described. At 80 kv the mean neutron yield is 1.5×10^5 per D + D reaction pulse. (tr-auth)

6993 UP-DOWN ASYMMETRIES OF Λ- AND Σ-DECAYS. Ning Hu (Peking Univ.). Sci. Sinica (Peking), 10: 837-44(Nov. 1961). (In English)

It is shown that the observed up-down asymmetries of hyperon decays can be understood when the effect of strong interactions is taken into account. Analysis of decay processes leads to information concerning renormalization or strength of the strong interactions. Results indicate that the strong interaction satisfies the condition for the "strong-coupling approximation." (auth)

6994 THE BROADENING OF SLOW ELECTROMAGNETIC WAVES IN A PLASMA CABLE. Gustav Biener (Technische Hochschule, Munich). Z. angew. Phys., 13: 457-65(Oct. 1961). (In German)

A measurement method is described which permits the wave parameters of an advancing wave to be measured at an arbitrary site with respect to a strong coherent signal. The application of the phase difference measurement method is limited to a stationary plasma in which the complex dielectric constant is temporally independent. The contribution and direction of the phase velocity and the group velocity of the broadening waves were determined. On the basis of these methods it was possible during measurements on the plasma cable to distinguish between a forward wave (a wave with corresponding direction of phase and group velocity) and a backward wave (a wave in which these directions are opposite). The method did not permit with "stationary" waves the separation of these waves from each other and the detection of the existence of a backward wave whose occurrence was limited by a finite value of the concentration of the charge carrier at the plasma boundary. The complete comprehension of the broadening parameter through the phase difference method leads to the detection of the effects of the electron drift velocity on the wave broadening. The contribution of the drift velocity in a nonisothermal stationary low pressure mercury discharge was determined. The application of the phase difference method necessitates an advancing wave in the plasma cable which is not perturbed by reflection. The plasma cable therefore was reflection-free. The damping of the advancing wave is shown from the comparison of the amplitudes of two receiving sites. Through logarithmic calibration of the indicator instruments at the collection outlet, the damping value could be read directly in Neper/cm. The conductivity of the plasma was determined from the measured damping values at low frequencies. At known electron concentrations, which result from the limiting frequency of the transfer range, the impact number of electrons is obtained from the measured value of the conductivity. The value agrees well with the values obtained from probe measurements. For the existence of a dependent gas discharge the region filled by the plasma is of secondary importance. The plasma serves only for the transmission of the current between the anode and the cathode drop region of the discharge and represents a conductor with relatively poor conductivity. The measurements carried out at low frequencies (1.2 Mc) on the plasma cable have ratified this behavior. (tr-auth)

6995 THE PRACTICAL SOLUTION OF THE RELATIVISTIC SINGLE ELECTRON EQUATION. [PART] II. Egil A. Hylleraas (Universitetet, Oslo). Z. Physik, 164: 493-506(1961). (In German)

For the representation of the radial components of the wave functions of the Kepler Problem, those Laguerre polynomials or confluent hypergeometric series which transfer directly into nonrelativistic eigenfunctions were used. The normalization of the wave functions of closed states was carried out, and the wave functions of the open state were indicated. In the force-free case, solutions were produced from a single component function by means of a matrix operator, and plane waves were converted into four-component spherical waves, which are individual solutions of the force-free wave equation. (tr-auth)

6996 INELASTIC INTERACTION BETWEEN 6.8 Bev/c π^--MESONS AND NUCLEONS. N. G. Birger, Kang-ch'ang Wang, Ts'u-tsêng Wang, et al. (Joint Inst. for Nuclear Research, Dubna, USSR). Zhur. Eksptl'. i Teoret. Fiz., 41: 1461-74(Nov. 1961). (In Russian)

An analysis is made of 355 interactions between π^- mesons and nucleons. The momentum and angular distributions of the secondary charged particles are measured. Data on π^0 mesons produced in the interactions are obtained. The data are compared with the statistical theory. The results suggest that peripheral interactions may exist. (auth)

6997 EFFECT OF POLARIZATION OF THE MEDIUM ON DEVELOPMENT OF ELECTRON-PHOTON SHOWERS. G. A. Timofeev (Moscow State Univ.). Zhur. Eksptl'. i Teoret. Fiz., 41: 1487-92(Nov. 1961). (In Russian)

A one-dimensional cascade theory of electron-photon showers is developed in approximation A for a dense medium by taking into account polarization of the medium. The integral energy spectra of shower particles at depths t = 1 and t = 2 in lead and air are computed. The results of the calculations are compared with the data of the usual cascade theory. (auth)

6998 THE SIGN OF THE K_1^0 AND K_2^0-MESON MASS DIFFERENCE AND THEIR LEPTONIC DECAYS. S. G. Matinyan (Inst. of Physics, Academy of Sciences, Georgian SSR). Zhur. Eksptl'. i Teoret. Fiz., 41: 1503-6(Nov. 1961). (In Russian)

Interference of leptonic decays of K^0 mesons during traversal of K_2^0 mesons through matter is investigated from the viewpoint of the possibility of determining the sign of the K_1^0 and K_2^0 mass difference. (auth)

6999 ON SCATTERING OF γ-QUANTA BY NUCLEONS. L. I. Lapidus and Kuang-chao Chou (Joint Inst. for Nuclear Research, Dubna, USSR). Zhur. Eksptl'. i Teoret. Fiz., 41: 1546-55(Nov. 1961). (In Russian)

An analysis of elastic scattering of γ quanta with energies up to 300 Mev by protons is carried out by the dispersion relation method. Six dispersion equations are used to estimate the real part of the amplitudes at $Q^2 = 0$. Photoproduction of pions is taken into account in a broader energy range than previously. Five subtraction constants are defined by the low energy limit and are expressed in terms of the charge and nucleon magnetic moment. The differential cross sections and polarization of the recoil nucleons are estimated. High energy γ-N scattering is discussed. (auth)

7000 THE FORMATION OF BIMUONIUM IN ELECTRON-POSITRON COLLISIONS. V. N. Baier and V. S. Synakh (Inst. of Nuclear Physics, Siberian Branch of the Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 41: 1576-81(Nov. 1961). (In Russian)

The formation and properties of the bound state of positive and negative muons (bimuonium) are investigated. The possibility of observing bimuonium is discussed. (auth)

7001 EFFECT OF π-MESON MASS DIFFERENCE ON THE RELATIONS BETWEEN THE $K_{\pi 3}$-DECAY PROBABILITIES. V. B. Mandel'tsveig and V. V. Solov'ev. Zhur. Eksptl'. i Teoret. Fiz., 41: 1606-8(Nov. 1961). (In Russian)

The effect of π-meson mass difference on the isotopic relations between $K_{\pi 3}$ decay probabilities is taken into account. Substitution of the π^0 for the $\pi^\pm$ enhances the phase volume by approximately 12%. The ratios of the statistical weights of the reactions under consideration are presented. (auth)

7002 ON THE ANALYTICAL PROPERTIES OF THE SINGLE-FERMION GREEN'S FUNCTION IN QUANTUM THEORY OF MANY PARTICLES. S. V. Maleev (Leningrad Inst. of Physics and Tech.). Zhur. Eksptl'. i Teoret. Fiz., 41: 1675-80(Nov. 1961). (In Russian)

The analytical properties of the single-fermion Green's function and the mass operator in quantum theory of many particles are investigated. In particular, the poles of the mass operator are studied. (auth)

7003 TRANSFORMATION OF PHOTONS INTO NEUTRINO PAIRS AND ITS SIGNIFICANCE IN STARS. S. G. Matinyan and N. N. Tsilosani (Inst. of Physics, Academy of Sciences, Georgian SSR). Zhur. Eksptl'. i Teoret. Fiz., 41: 1681-7(Nov. 1961). (In Russian)

The cross section for transformation of a γ quantum into a $\nu\bar{\nu}$ pair is calculated and the cross section for transformation of two photons into $\nu\bar{\nu}$ is estimated. The luminosities of stars corresponding to these processes are computed. Within a broad range of temperature and density of the stars these processes are found to dominate the Bremsstrahlung of $\nu\bar{\nu}$ pairs by electrons. (auth)

7004 ON THE PRECULIARITY OF π^0 MESON PHOTOPRODUCTION AT A THRESHOLD. A. M. Baldin and A. I. Lebedev (Lebedev Inst. of Physics, Moscow). Zhur. Eksptl'. i Teoret. Fiz., 41: 1688-9(Nov. 1961). (In Russian)

An analysis of photoproduction at an angle $\theta = 0^0$ (where the most pronounced deviations were previously found) indicated an effect that is sensitive to the variations in dispersion integrals. The developed data offer useful information on parameters of low-energy π-meson physics. (R.V.J.)

Neutron Physics

7005 (WAPD-T-1234) THE APPLICATION OF A THERMAL GROUP MODEL FOR ACTIVATION CALCULATIONS. D. R. Connors, R. J. Breen, C. A. Johnson, H. J. Litke, and D. S. Rampolla (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). July 1961. Contract [AT(11-1)-Gen-14]. 19p.

Presented at American Nuclear Society Meeting in San Francisco, December 1960.

A description is given of a model for a better approximation of the thermal neutron energy problem than may be obtained by assuming either a Maxwellian or a SOFOCATE spectrum by itself. Comparisons are made of the model with multigroup calculations, and of activation calculations with experimental measurements. (B.O.G.)

7006 (AEC-tr-4963) DETERMINATION OF THE NEUTRON FLUX ENERGY DISTRIBUTION IN ACTIVATION AND TRANSMISSION EXPERIMENTS. M. Sabău and I. Zamfirescu. Translated from Acad. rep. populare Romîne, Inst. fiz. atomica şi Inst. fiz., Studii cercetări fiz., 11: 351-6(1960). 6p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 22290.

7007 NON-STATIONARY PROBLEM OF HEAT AND NEUTRON TRANSFER IN A NON-MULTIPLYING MEDIUM. E. A. Romashko (Inst. of Power Engineering, Academy of Sciences, Minsk). Inzhener.-Fiz. Zhur., Akad. Nauk Belorus. S.S.R., 4: No. 10, 40-3(Oct. 1961). (In Russian)

Formulas are obtained for the distribution of thermal monoenergetic neutrons in absorbing and non-absorbing infinite plates heated by a constant heat flow and with symmetric constant flow of neutrons to the plates. (auth)

7008 IMPROVED DIFFUSION APPROXIMATION OF THE TRANSPORT EQUATION FOR PLANE PROBLEMS. Juergen Lieberoth (INTERATOM, Bensberg, Ger.). Nukleonik, 3: 185-8(Oct. 1961). (In German)

The simple diffusion approximation of the neutron transport equation can be applied only in such problems in which for each coherently homogeneous material range the ratio of volume to the contact surface is large with respect to the free path length $\underline{l}$. It is shown how the neutron flux can be calculated independently of this limitation and accurately with a generalized diffusion equation for plate geometry and isotropy of the neutron scattering and sources. It is also shown how the error can be estimated in well-defined ways. (tr-auth)

7009 NEUTRON MODERATION IN ICE AT 90°K. Wolfgang Maenner (Technische Hochschule, Munich). Nukleonik, 3: 285-92(Dec. 1961). (In German)

The neutron spectrum in ice at 90°K was investigated. In order to avoid the usual systematic sources of error in differential measurements of the spectra, an integral method was used. An effective neutron temperature T_n was defined by the transmission of a $\frac{1}{2}$-absorber; this was measured by means of activation of a dysprosium probe, which was screened with an indium filter. The result at 90°K ice temperature was $T_n = 212 \pm 15$°K and at 273°K $T_n = 335 \pm 23$°K. The ratio of the neutron density was determined to be $\bar{n}(90°K)/\bar{n}(273°K) = 1.20 \pm 0.05$, in good agreement with theoretical estimates. Likewise, a general rela-

tion was derived for the yield of slow neutrons by means of the cooling of the moderator and the connected "cooling off" of the neutrons to T_n. The experimentally determined yield for subthermal neutron energies was about 2.4. For complete adjustment of the thermal equilibrium between neutrons and moderator it was 6.4. The results were compared with other authors. (tr-auth)

7010 THE TRANSPORT THEORY OF THERMAL NEUTRONS IN HEAVY GAS MODERATOR. Zbigniew Weiss (Inst. of Nuclear Research, Warsaw). Nukleonika, 6: 691-701(1961). (In English)

The solution of the multivelocity Boltzmann equation describing the migration of thermal neutrons near the equilibrium state in a heavy gas moderator is reduced to the solution of a set of one-velocity Boltzmann equations for the energy moments of the distribution function expansion in Laguerre polynominals. In the constant cross section approximation, equations for the moments are not coupled; differ from one another only by the "effective" number secondaries c_j. By means of the resolvent operator the equations for the complementary g_j functions were derived; added to the isotropic constant cross section moments, they give a consequent solution in the 1/M approximation. The widely used P_1 approximation is discussed and the limiting conditions for J in the P_1L_J approximation are given. (auth)

7011 THE P_nL_j APPROXIMATION OF NEUTRON THERMALISATION IN HEAVY GAS MODERATOR. Zbigniew Weiss (Inst. of Nuclear Research, Warsaw). Nukleonika, 6: 703-16(1961). (In English)

The method developed previously for solving the multivelocity Boltzmann equation for neutron thermalization in heavy-gas moderators is illustrated by means of the expansion of the energy moments in spherical harmonics. Due to the orthogonality properties of the coupling coefficients $G(\nu_j)$ the general solution of the problem is given. In order to give a clear formulation of the method, vector notation is used. The Milne problem is solved in P_3L_j approximation. The variation of the extrapolation length is calculated (the diffusion affect), and the local decrease of neutron temperature at the boundary is found (the transport effect). (auth)

Nuclear Properties and Reactions

7012 (DC-59-7-171) SOME NEUTRON INDUCED CROSS SECTIONS FOR ELEMENTS PERTINENT TO XMA, PART 2. H. A. Gerardo (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). July 16, 1959. Contract AT(11-1)-171. 91p.

A continuation of a previous report (DC 59-5-45) is presented in which a preliminary compilation of the empirical cross sections for neutron-induced reactions of elements pertinent to the XMA Project are given. Data on neutron cross sections for the remaining elements after O^{16}, and the heavy elements are given for the energy range fifteen to twenty Mev. (auth)

7013 (IFA-EM-42) ON THE INTERPRETATION OF DOUBLE-MAXIMUM ANGULAR DISTRIBUTIONS IN HIGH-ENERGY NUCLEON INTERACTIONS. E. M. Friedlaender (Academia R. P. R. Institutul de Fizica Atomica, Bucharest). Feb. 2, 1961. 30p.

The double-maximum angular distributions observed in high-energy cosmic ray jets are discussed from the viewpoint of the two-center model. A kinematical model is proposed according to which a peripheral nucleon-nucleon collision reduces effectively to two quasi-independent pion-nucleon collisions. At low energies, the kinetic energy of the pions in the nucleon's rest system is assumed to be negligibly small, while at high energies a unique (discrete) energy value and angular isotropy is assumed. A sample of artificial jets is constructed by means of a Monte Carlo calculation based upon the above assumptions. Good agreement is found with the experimental data. The discrete energy value deduced from experiment is surprisingly near to the π-π resonance observed at lower energies. Alternative explanations of the strong observed anisotropies are discussed. (auth)

7014 (JINR-D-784) PRINCIPLE OF LEVELLING THE STATES AND ITS APPLICATION TO THE CALCULATIONS OF MULTIPLE PRODUCTION. G. I. Kopylov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1961. 17p.

For estimating the multidimensional integrals, the changes of the variables which decrease the variation of the integrand are useful. An approximate calculation of the statistical weights is based on this principle. The method is applied to the covariant phase space integrals, and it is shown that the covariant model reproduces the average multiplicity of the produced mesons just as well as the Fermi model does. It is also shown that the same choice of the variables decrease by some orders the time interval necessary for calculating the Fermi model by the Monte Carlo method. (auth)

7015 (JINR-D-794) HYPERON PRODUCTION ON LEAD NUCLEI BY K_2^0 MESONS WITH A MEAN ENERGY OF ABOUT 100-MeV. D. V. Neagu, E. O. Okonov, N. I. Petrov, A. M. Rosanova, and V. A. Rusakov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1961. 8p.

Hyperon production on lead nuclei by the K_2^0 with a mean energy of −100 Mev was studied by using a cloud chamber in a magnetic field. The cross section for $\Lambda^0(\Sigma^0)$ production on lead nuclei was estimated to be $\sigma = (200 \pm 70)$mb. The ratio of the cross sections for K_1^0 regeneration and for hyperon production is much less than unity (-3.10^{-2}). (auth)

7016 (JINR-D-812) AN EXPERIMENTAL INVESTIGATION OF μ-MESONIC ATOMIC PROCESSES IN GASEOUS HYDROGEN. V. P. Dzhelepov, P. F. Ermolov (Yermolov), E. (Ye.) A. Kushnirenko, V. I. Moskalev, and S. S. Gershtein (Gerstein) (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems and Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1961. 21p.

Mesonic atom processes in hydrogen were studied experimentally by means of a diffusion cloud chamber in the magnetic field. The following quantitative data were obtained: the cross section for elastic scattering of $p\mu$-mesonic atoms on protons $\sigma_{pp} = (1.7^{+0.4}_{-0.3}) 10^{-19}$ cm^2; the rates of the meson transfer from a proton to deuterons and complex nuclei (C and 0) recalculated to the liquid hydrogen density $\lambda_d = (0.95^{+0.34}_{-0.21}) 10^{10}$ sec^{-1} and $\lambda_z = (1.2^{+0.8}_{-0.5}) 10^{10}$ sec^{-1}; and the rate of the formation of mesonic molecular ions $pp\mu$ in liquid hydrogen $\lambda_{pp\mu} = (0.6^{+0.8}_{-0.3}) 10^6$ sec^{-1}. The experimental values of λ_d, $\lambda_{pp\mu}$, and λ_z are in good agreement with the theoretical ones which confirms the validity of the mechanisms of the processes suggested theoretically The cross section σ_{pp} was found to be close to the theoretical value calculated without the hyperfine structure of the $p\mu$ mesonic atom being taken into account. However, the possibility of the fast transitions to the lower state with the total spin of a mesonic atom F = 0 is not excluded. The determination of the absolute value of λ_d carried out in

this investigation allowed the absolute probabilities of a number of μ-mesonic molecular processes to be found by using it as a scale. (auth)

7017 (JINR-D-823) ELECTRON ACTIVATION OF MESIC ATOMS. A. E. Ignatenko, M. G. Petrashku, and D. Chultem (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1961. 4p.

The existence of the phenomenon of electron activation of mesic atoms leads to the fact that the probability of the muon transition R within the levels of hyperfine structure determined by the state of the electron shell of a mesic ion at the moment of its disintegration, will depend on a kind of combination to which the atom under study belongs. This was used to explain the fact that the values of R in mesic atoms of two phosphor modifications greatly differ. (M.C.G.)

7018 (NP-11213) NUCLEAR REACTIONS PRODUCED BY 2 MEV Li^6 ON Be^9. M. Coste, C. Lemeille, N. Saunier, and L. Marquez (Rio de Janeiro. Centro Brasileiro de Pesquisas Fisicas). 1961. 6p. (Notas de Física, Vol. VIII, No. 3, p.73-7).

The reactions produced by 2-Mev Li^6 on Be^9 were studied. Measurements with scintillators showed that the most intense gamma rays are those from the first excited state of Li^7 and B^{10}. Measurements with plates and junctions showed several groups of alpha particles from the double stripping reaction $Li^6 + Be^9 \rightarrow \alpha + B^{11}$. Coincidences between the junction spectra and the 479 kev gamma ray indicated that the double stripping reaction leading to a higher state is the primary reaction followed by break up of B^{11} in $\alpha + Li^7$ or $N + B^{10}$. (auth)

7019 (NP-11215) ANALYSIS OF THE K^+-DEUTERIUM EXPERIMENTS. Erasmo M. Ferreira (Rio de Janeiro. Centro Brasileiro de Pesquisas Físicas). 1961. 27p. (Notas de Física, Vol. VIII, No. 4, p.81-106).

Application was made of the results of the analysis of the K^+ meson-deuteron scattering in terms of elementary two-particle processes. It was assumed that only S-waves contribute to the K^+-neutron interaction. The data recently obtained with a deuterium bubble chamber on the charge exchange process $K^+d \rightarrow K^0pp$ were used and seem to confirm this assumption. Using these data two kinds of solutions were obtained for the scattering parameters in the isotopic spin zero state of the K-nucleon system. Measurements of the cross section for the inelastic (non-exchange) process $K^+d \rightarrow K^+np$ will decide for one of the two groups of solutions. (auth).

7020 (TID-14474) AN EXPERIMENTAL TEST OF THE SELECTION RULE $\Delta S = \Delta Q^*$. R. P. Ely, W. M. Powell, and H. White (California. Univ., Berkeley), M. Baldo-Ceolin, E. Calimani, S. Ciampolillo, O. Fabbri, F. Farini, G. Filippi, H. Huzita, and G. Miari (Padua. Universita. Istituto di Fisica), U. Camerini, W. Fry, and S. Natali (Wisconsin. Univ., Madison). Dec. 27, 1961. Contract AT(11-1)-881. 18p.

The selection rule $\Delta Q = \Delta S$ means that leptonic decays of strange particles are allowed only when the difference in charge between the initial and final strongly interacting particles in the decay is equal to the difference in strangeness. The rule was tested by means of experiments on the leptonic decays of neutral K mesons in the exposure of a propane bubble chamber to a separated K^+ beam. It is concluded that the $\Delta Q = \Delta S$ selection rule is not valid. (D.L.C.)

7021 (UCRL-9850) THE MOMENTS, SPINS, AND HYPERFINE STRUCTURES OF THE RADIOACTIVE ISOTOPES: I^{133} (21-hr), Nd^{141} (2.5-hr), Eu^{152} (13-yr), AND Bi^{210} (5-day) (thesis). Seymour S. Alpert (California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 6, 1961. 126p.

The atomic beam "flop-in" technique was used to measure the nuclear constants of the radioactive species, I^{133}, Bi^{210}, Po^{210}, Nd^{141}, and Eu^{152}. The resulting values for the nuclear spin, I; the magnetic dipole interaction constant, a; and the electric quadrupole interaction constant, b; are tabulated. The values of several hyperfine-structure separations were also directly measured or calculated. These nuclear constants are indicated by the symbol $\Delta\nu_{F,F'}$ where the subscripts indicate the total angular momentum involved. (auth)

7022 (UCRL-9874) HYPERFINE-STRUCTURE MEASUREMENTS ON RUBIDIUM-81 AND -82 (thesis). John Daly Faust (California. Univ., Berkeley). Lawrence Radiation Lab.). Sept. 30, 1961. Contract W-7405-eng-48. 59p.

The atomic-beam magnetic-resonance method was used to measure the hyperfine-structure separation in two neutron-deficient isotopes of rubidium, Rb^{81} and Rb^{82}. In the $^2S_{1/2}$ electronic state, observation of $\Delta F = \pm 1$ lines at very low field values allows very accurate determination of $\Delta\nu$. The following values were obtained: $\Delta\nu_{81} = 5111.589 \pm 0.040$ Mc and $\Delta\nu_{82} = 3094.084 \pm 0.006$ Mc. Details of construction of the apparatus are presented along with a brief outline of the theory of the hyperfine interaction. (auth)

7023 THE CALCULATION OF THE PROBABILITIES OF FORBIDDEN γ TRANSITIONS OF THE M3 AND β TYPE OF THE SECOND ORDER, AS WELL AS THE MOMENT OF INERTIA OF ATOMIC NUCLEI BY THE NILSSON MODEL. D. Bogdan. Acad. rép. populaire Roumaine, Rev. phys., 6: 31-47(1961). (In French)

A consideration is made of nuclear phenomena whose mathematical expression includes the operator $r'^2Y_{2,0}D^2_{M,0}$ and where the use of the corrected representation can be very important. It is concerned with forbidden γ transitions of the M3 and β type of the second order. The moments of inertia were studied in the approximation of the rigid nuclei in order to illustrate the application of results obtained previously. In the case of these transitions, if certain selection rules are satisfied and if the coefficients in the wave functions have suitable values, the utilization of the corrected representation is necessary. In the case of rigid moments of inertia, the utilization of this representation is not too important. (J.S.R.)

7024 ANGULAR DISTRIBUTION OF 6.2 Mev PROTONS ELASTICALLY AND INELASTICALLY SCATTERED BY S^{32}. H. Hulubei, N. Martalogu, M. Ivaşcu, C. Beşliu, A. Berinde, I. Neamu, and J. Franz (Institutul de Fizica Atomica, Academia R. P. R., Bucharest). Acad. rép. populaire Roumaine, Rev. phys., 6: 97-103(1961). (In French)

A study was made of the angular distribution of inelastically scattered 6.2-Mev protons leaving S^{32} in its first excited state at 2.25 Mev. The shape of the curve of elastic angular distribution appears to confirm the predictions of the optical model with Coulomb forces. The angular distribution of inelastically scattered protons shows an asymmetry with respect to 90°. The preference for the forward direction seems to favor a direct interaction mechanism for S^{32}. (J.S.R.)

7025 THE PULSE DISTRIBUTION OF NUCLEONS IN THE ATOMIC NUCLEUS. Zs. Csoma (Univ. of Technical Sciences, Budapest). Acta Phys. Acad. Sci. Hung., 13: 241-3(1961). (In German)

The pulse distribution of nucleons in nuclei can be calculated in a manner similar to the calculation of the pulse distribution of atomic electrons, since the nucleons also obey Fermi statistics. The patterns of the distribution functions ϕ and r for the mass numbers 16, 80, and 200 were calculated and graphed. (J.S.R.)

7026 ON THE DEFORMABILITY OF NUCLEAR CORES AND THE ELECTRIC QUADRUPOLE MOMENT OF NUCLEI WITH CLOSED SHELLS PLUS (OR MINUS) A SINGLE NUCLEON. Han-chou Liu (Nan-kai Univ., Tientsin, China) and Kuo-shen Yang. Acta Phys. Polon., 20: 801-8(1961). (In English)

Using the self-consistency condition and the first order perturbation method and assuming that the nuclear self-consistent field is the Nilsson potential, the deformability of nuclear cores and the electric quadrupole moment of nuclei with a doubly closed shell core ± one nucleon are calculated. The former case shows exact agreement with observation and the latter fits the experimental data as well as other best methods. (auth)

7027 SCATTERING OF He^3 PARTICLES AT 29 Mev BY CCl_4. II. STUDY OF THE PICK-UP REACTION $C^{12}(He^3,\alpha)C^{11}$. J. Catalá, A. Lleó, A. García, and J. Aguilar (Facultad de Ciencias, Valencia). Anales real soc. españ. fís. y quím. (Madrid), Ser. A, 57: 51-4(Mar.-Apr. 1961). (In Spanish)

In an earlier paper the elastic scattering of 29-Mev He^3 particles by chlorine, from a CCl_4 target, was studied using the photographic technique. This work was continued with the study of the $C^{12}(He^3,\alpha)C^{11}$ pick-up reaction, and the angular distribution is presented and compared with that predicted by the Butler model, an interaction radius of 3.5 fermis was obtained. (auth)

7028 MEASUREMENTS OF THE β-γ CIRCULAR POLARIZATION ANGULAR CORRELATION IN Re^{186}. M. Delabaye, J. Deutsch, and P. Lipnik (Université, Louvain, Belg.). Ann. soc. sci. Bruxelles. Sér. I, 75: 171-3 (1961). (In French)

The β-γ polarization correlation is measured as a function of θ for the non-unique first-forbidden β decay of Re^{186} The observed polarization furnishes proof that this transition cannot be described by the ξ approximation. (T.F.H.)

7029 BETA-GAMMA DIRECTIONAL CORRELATION IN Ho^{166}. J. P. Deutsch, L. Grenacs, and P. Lipnik (Université, Louvain, Belg.). Ann. soc. sci. Bruxelles. Ser. I, 75: 191-3(1961). (In French)

The directional correlation in the 1770-kev-β-80-kev-γ decay of Ho^{166} to Er^{166} is measured using a Ho_2O_3 sample. It is found that the cascade proceeds through the states 0–, 2+, 0+, and that the correlation is attenuated (in Ho_2O_3) to 0.28 times its theoretical value. It is also found to be impossible to exclude the possibility of an alternative sequence 1–, 2+, 0+, without a knowledge of the γ-γ attenuation factor in Ho_2O_3. (T.F.H.)

7030 THE K AUGER SPECTRUM OF Eu. Tito Suter and Pilar Reyes-Suter (Inst. of Physics, Uppsala). Arkiv Fysik, 20: 393-8(1961). (In English)

The K Auger spectrum of Eu resulting from the decay of Sm^{153} was studied using an iron-yoke double-focusing spectrometer. Energies and intensities are given and compared with theoretical predictions. The value 0.908 ± 0.007 was obtained for the fluorescence yield. (auth)

7031 DETERMINATION OF THE 3.3 ± 0.2 NSEC HALF-LIFE OF THE 103.2 kev LEVEL IN Eu^{153}. P. Reyes-Suter and T. Suter (Inst. of Physics, Uppsala). Arkiv Fysik, 20: 399-402(1961). (In English)

A half life of 3.3 ± 0.2 nanoseconds was remeasured for the 103.2–kev level in Eu^{153} by the delayed electron-electron coincidence technique. Electromagnetic transition probabilities are given. (auth)

7032 ELECTROMAGNETIC TRANSITION PROBABILITIES IN ODD-A MERCURY ISOTOPES. Pilar Reyes-Suter and Tito Suter (Inst. of Physics, Uppsala). Arkiv Fysik, 20: 415-29(1961). (In English)

The following half lives of low excited levels in the odd-A mercury isotopes were determined using delayed electron-electron coincidence measurements: 0.8 ± 0.1 nsec for the 39 kev level in Hg^{193}; 7.0 ± 0.2 nsec for the 134-kev level in Hg^{197}; 2.53 ± 0.15 nsec for the 158-kev level in Hg^{199}; <0.2 nsec for the 32-kev level in Hg^{201}. A recently proposed decay scheme for Hg^{195m} was confirmed by electron-electron coincidences and it was found that one of the low lying levels has a half-life of 0.79 ± 0.07 nsec. Transition probabilities are given and compared with the single particle estimates. Experimental delayed coincidence techniques and difficulties due to the low energy of the radiations involved are discussed. (auth)

7033 DECAY OF Ag^{105} TO Pd^{105}. T. Suter, P. Reyes-Suter, W. Scheuer, E. Aasa, and G. Baeckstroem (Inst. of Physics, Uppsala). Arkiv Fysik, 20: 431-60(1961). (In English)

The decay of Ag^{105} ($T_{1/2}$ = 40 days) to Pd^{105} was studied using an iron yoke double focusing spectrometer of 50–cm radius. The activities were obtained using the Pd(d,xn)Ag and the $Rh^{103}(\alpha,2n)Ag^{105}$ reactions. Internal conversion lines of a large number of transitions, more than 30 of them were unknown before, were found to belong to Ag^{105}: 63.97; 89.96; 112.35; 155.37; 158.93; 182.78; 186.6; 187.4; 280.37; 285.1; 285.9; 286.7; 289.2; 306.1; 319.0; 325.3; 328.4; 331.4; 344.39; 350.5; 360.6; 370.1; 392.5; 401.5; 402.8; 407.8; 414.4; 420.9; 437.1; 443.3; 446.5; 560.7; 617.7; 636.6; 644.4; 650.7; 673.2; 681.4; 727.2; 743.7; 807.6; 962.8; and 1088.0 kev. The energies were determined with an accuracy of a few parts in 10^4. Electron-gamma and electron-electron coincidence measurements were performed using magnetic lens spectrometers and a gamma scintillation spectrometer in conjunction with a 400 channel analyzer in order to establish the decay scheme. The following excited levels are proposed: 280.4; 306.2; (319.1); 344.4; 489.0; (560.7); (644.4); 650.6; 673.1; 727.1; 962.3; (1001.5) and 1087.8 kev. (auth)

7034 NUCLEAR SPIN MEASUREMENTS ON NEUTRON-DEFICIENT TELLURIUM ISOTOPES. S. Axensten, G. Liljegren, and I. Lindgren (Univ. of Uppsala). Arkiv Fysik, 20: 473-8(1961). (In English)

The atomic-beam magnetic-resonance technique was used to measure the nuclear spins of some cyclotron-produced tellurium isotopes with the following results: Te^{118} (2.5 hours) I = 0, Te^{117} (61 min) I = $\frac{1}{2}$, Te^{119} (4.5 days) I = $\frac{11}{2}$ and Te^{119} (16 hours) I = $\frac{1}{2}$. These results are consistent with recent spectroscopic observations of these isotopes and are discussed in relation to the nuclear shell model. The atomic g-value of tellurium was measured using spin-zero isotopes. The result, g_J = 1.4618(2), is in agreement with the theoretical value, if the partial breakdown of the LS-coupling is considered. (auth)

7035 STUDY OF THE $Be^9(d,t)Be^8$ REACTION. V. I. Serov, V. A. Pereshivkin, M. F. Andreev, and I. K. Aver'yanov. Atomnaya Energ., 11: 440-2(Nov. 1961). (In Russian)

The differential cross section of the $Be^9(d,t)Be^8$ reaction

under an angle of 17° was measured at neutron energies ranging from 1.125 to 3.8 Mev, together with determination of the angular distribution between 0 and 150°, making use of a deuteron beam incident upon a Be foil placed in a magnetic spectrometer. A CsI crystal and a photomultiplier and a 50-channel amplitude analyzer serves as the detector. Resonances were found at neutron energies of 1.16, 1.37, and 2.85 Mev. The angular distributions at 1.4, 2.5, and 3.5 Mev were also measured; the experimental data agreed well with theoretical values if it is assumed that the radius of interaction $r_0 = 4.10^{-13}$ cm for $E_d = 1.4$ Mev and 5×10^{-13} cm for $E_d = 2.5$ and 3.5 Mev. The resonances are due to B^{11} nuclei with excitation energies of 16.77, 16.93, and 18.11 Mev. The total formation cross section of the tritons was found to be 60 ± 10 millibarn. A definite correlation has been found to exist between the thresholds of inelastic interaction and the position of certain resonances of the reactions of Be^9 with neutrons, protons, deuterons and α-particles. A similar behavior was noted also in the case of other light nuclei, such as Li^7 and B^{10}. (TTT)

7036 INELASTIC INTERACTION CROSS SECTION OF FISSION SPECTRUM NEUTRONS. G. N. Lovchikova and O. A. Sal'nukov. Atomnaya Energ., 442-3(Nov. 1961). (In Russian)

The $\underline{T}$ value, defined as the ratio of the count rate of fission neutrons with and without the specified scatterer, was determined for a number of elements. A converter consisting of a 75% enriched U^{235} oxide and a fission chamber containing U^{238} depleted in U^{235} by a factor of 100 with respect to the natural mixture were used for the experiments. The chamber, shielded with Cd against thermal neutrons, had an effective threshold of 1.4 Mev for fission neutrons. The spheric scatterers consisted of the natural isotopic mixtures of the materials investigated. The difference in counting rate with and without scatterer is due to reactions resulting in neutron energy losses below the threshold value of the detector, depending primarily on inelastic scattering because the capture cross sections of the materials studied in the energy range of 1 to 14 Mev lie within 1 to 10 millibarns; the (n,α) and the (n,2n) reactions may also be neglected. The following $\underline{T}$ values were obtained: Na−0.037; K−0.981; Sr−0.950; Ba−0.933; Mo−0.727; Nb−0.883; Fe−0.807. With the exception of Fe, the values are published for the first time. The data indicate an increase of $\underline{T}$ with the atomic number. (TTT)

7037 SPECTRA AND ANGULAR DISTRIBUTION OF THE SCATTERED GAMMA-RAYS IN IRON ORIGINATING FROM A TWO DIMENSIONAL AND UNIDIRECTIONAL Co^{60} SOURCE. A. V. Larichev. Atomnaya Energ., 11: 443-5 (Nov. 1961). (In Russian)

A total-absorption spectrometer with a cylindrical NaI(Tl) crystal was used for the measurement of the spectral and angular distribution of γ-rays generated in a Fe barrier layer with thickness of 6 times the mean free path of the particles (15.6 cm) under angles of 20, 50, and 70°. The highest points of the angular distribution curves of the scattered γ-ray intensities indicated an exponentital correlation between the intensity of the scattered radiation per unit of body angle and the angle. For all the thicknesses studied, a maximum was obtained between 20 and 30°. A satisfactory agreement was obtained between the experimental results and values calculated from data reported by M. Berger and J. Doggett (Journal of Research Nat. Bureau of Stand. 56, (1956) No. 2). (TTT)

7038 THE EFFECT OF THE RESONANCE STRUCTURE CROSS SECTION ON THE SCATTERING OF FAST NEUTRONS IN IRON. M. N. Nikolaev, V. V. Filippov, and I. I. Bondarenko. Atomnaya Energ., 11: 445-7(Nov. 1961). (In Russian)

The effect of resonance blocking on the transport and slowing-down cross sections was not taken into account except in the case of isolated resonances although this effect is quite marked even for heavy atoms at relatively high energies. For medium-weight nuclei the resonance structure cross section is noticeable up to energies of the order of several Mev. An expression was derived for estimating the dispersion of the cross section. The experimental arrangement consisted of a neutron source based on the $T(p,n)H^3$ reaction, directing the protons accelerated by an electrostatic generator onto a titanium−tritium target, carrying out the measurements at an angle of 0°. An Armco iron cylinder was used as scatterer; the neutrons passing through without collision impinged on a detector and were recorded by means of 48 proportional counters, within a paraffin block. Scattering curves were measured for neutron energies within the 0.3 to 1.8-Mev range; the results indicated a strong fluctuation of the cross section within this range. The average values obtained were found to lie about 10 to 20% higher than the cross sections given in D. Yuz' Atlas on the nuclear cross section of elements; this might be because of the differences in the thicknesses used. The data reported should be considered as preliminary. (TTT)

7039 AN EXACT SOLUTION OF THE TRANSIENT-STATE ALBEDO PROBLEM. T. Kh. Sedel'nikov. Atomnaya Energ., 11: 449-50(Nov. 1961). (In Russian)

A homogeneous, isotropic, elastically scattering half-space is considered for the purpose of determining the neutron flux as a function of time on the basis of the corresponding albedo equation. The equation is derived from the transition to the stationary from the transient state, by means of Laplace transforms. From the stationary kinetic equation the corresponding albedo equation is then obtained, determining the output current. The transient-state albedo equation may also be derived from the invariance principle by Laplace transforms. The mathematical derivations are given. (TTT)

7040 NEUTRONS AND GAMMA RAYS FROM Po^{210}−$B^{10}(\alpha,n)$ AND Po^{210}−$B^{11}(\alpha,n)$ SOURCES. K. W. Geiger and C. J. D. Jarvis (National Research Council, Ottawa). Can. J. Phys., 40: 33-48(Jan. 1962). (NRC-6605)

The neutron energy spectra from Po−$B^{10}(\alpha,n)$ and Po−$B^{11}(\alpha,n)$ sources were determined by the nuclear emulsion method and with a proton recoil spectrometer. Gamma spectra were also measured. The Po−B^{10} neutron spectrum extends to an energy of 6.0 Mev and shows two peaks, at 1.0 and 3.0 Mev. The lines in the gamma spectrum are not in coincidence with neutrons but are caused by competing reactions. The Po−B^{11} neutron spectrum shows one peak at 2.7 Mev; the maximum energy observed is 5.0 Mev. One γ-ray line at 2.32 Mev with an intensity of 5% of the neutron emission rate is detected in the gamma−neutron coincidence measurements. The experimental neutron energy spectra were compared with calculated spectra and are compatible with the gamma measurements, as well as with published level schemes for the residual N^{13} and N^{14} nuclei. In the case of the Po−B^{10} source only one-third of the neutrons are produced by the $B^{10}(\alpha,n)N^{13}$ reaction and the remainder has to be accounted for by the $B^{10}(\alpha,np)C^{12}$ reaction. (auth)

7041 COMPOUND NUCLEUS FORMATION IN NITROGEN−OXYGEN AND OXYGEN−OXYGEN REACTIONS. W. A. Cartledge (Univ. of Montreal). Can. J. Phys., 40: 139-49(Jan. 1962).

The experimental cross section for the reaction $O^{16}(N^{14}, 2p)Al^{28}$ is compared with the predictions of the square-well model of compound nucleus formation over the range 6.3 to 12 Mev (center of mass energy). The branching ratio is estimated from the experimental cross section for the comparison reaction $Si^{29}(p,2p)Al^{28}$ over the same range of excitation in the compound nucleus P^{30*}. It is found that the branching ratio probably increases from about 10% to 20%, which requires the nuclear interaction radius for $N^{14} + O^{16}$ to decrease from about 8.5 to 7.5 Fermis as the energy is increased over this range. Because of the similarity in mass and observed charge distributions in N^{14} and O^{16}, the interaction radius for compound nucleus formation in a collision between two oxygen nuclei is probably also similar and in the range 8.0 to 9.1 Fermis at energies far below the Coulomb barrier. A consequence of this result is that oxygen ions, which may be present in the cores of sufficiently developed red giant stars, will be destroyed by $O^{16} + O^{16}$ collisions in about 10^5 years and 1 year respectively, at temperatures in the vicinity of 13.0 and 18.5×10^8°K. (auth)

7042 EVIDENCE OF THE QUADRUPOLE MOMENT OF THE NUCLEUS OF IRON-57. Jean Gastebois and Jacques Quidort. Compt. rend., 253: 1257-9(Sept. 18, 1961). (In French)

An experiment analogous to that of Kistner and Sunyar (Phys. Rev. Letters 4: 412(1960)), made at 25°C, was made at very low temperature. The displacement found, ϵ', characterizing the quadrupole interaction of Fe^{57*} in Fe_2O_3, was of opposite sign and twice that found by Kistner and Sunyar. This shows that the field gradient is perpendicular to the crystal axis at 25°C and is parallel at very low temperatures (liquid nitrogen). (tr-auth)

7043 CALCULATION OF THE FIRST EXCITED STATES OF THREE ISOTOPES OF LEAD Pb^{202}, Pb^{204}, AND Pb^{206}. QUADRUPOLAR TRANSITIONS. Gisèle Espi and Georges Monsonego (Université, Algiers). Compt. rend., 253: 2472-4(Nov. 27, 1961). (In French)

Calculations are presented for the first excited states and for the reduced probabilities B(E2) of quadrupole transitions from these states. The calculations are based on a quasi-particle formalism, and take into account the effect on interactions between quasi-particles. (tr-auth)

7044 THE ENERGY LEVELS OF Gd^{158} AND Gd^{158}. L. V. Groshev, A. M. Demidov, V. A. Ivanov, V. N. Lutsenko, and V. I. Pelekhov. Doklady Akad. Nauk S.S.S.R., 141: 59-62(Nov. 1, 1961). (In Russian)

The γ-ray spectra and internal conversion electron spectra were determined for Gd^{156} and Gd^{158} which were obtained by $(n\gamma)$ reactions on enriched targets of Gd^{155} and Gd^{157}. From the γ-ray spectrum, the binding energy of the neutron was found to be 7937 ± 5 kev in Gd^{158}, and 8531 ± 5 kev in Gd^{156}. The 6960- and 6911-kev γ-transitions go to the well-populated 978 and 1025 kev levels which have characteristics of 1^- and 2^- respectively in Gd^{158}. The existence of a 1044-kev level with a characteristic of 3^- in Gd^{158} is also proposed on the basis of the difference in energies of two intense E1 transitions with energies of 964 and 778 kev. The presence of levels with a negative parity in Gd^{158} at an excitation energy of about 1 Mev is probably associated with the break-up of a pair of nucleons with the transformation of one nucleon into another state. Levels with a negative parity were observed in Gd^{156} at 1273 and 1316 kev. A comparison of the γ-ray spectra and internal electron conversion spectra in the 900- to 1200-kev energy interval for Gd^{156} shows that in the case of the 1011- and 1041-kev transitions, the conversion coefficients are greater than in the 960-, 1065-, and 1159-kev E2-transitions. It is assumed that the 1011-kev line corresponds to a $0^+ \rightarrow 0^+$ transition, while the 1041-kev line corresponds to a 2^+ transition (1130 kev) $\rightarrow 2^+$ (89 kev). The 1427-kev transition in Gd^{158}, which also has a very large conversion coefficient, is assumed to correspond to a $0^+ \rightarrow 0^+$ transition. (TTT).

7045 MEASUREMENT OF THE NEUTRON SPECTRUM OF A Pu–Be SOURCE. Z. Lewandowski, P. Huber, and R. Wagner (Universität, Basel). Helv. Phys. Acta, 34: 457-9(1961). (In German)

The neutron spectrum of a Pu–Be source containing 9.99 g Pu was determined using the time-of-flight method. The experimental apparatus is shown. The neutrons were measured in a cylindrical scintillator. The time-of-flight spectrum of neutrons scattered at the first scintillator was measured with a time analyzer. The energy spectrum calculated from the results are given, and maxima are indicated at about 3.0 and 6.2 Mev. The probable errors in the measurements originate principally from the finite space angle and were probably less than 6% up to 3 Mev and increased to 6.5% at 9.3 Mev. (J.S.R.)

7046 POSITRON SPECTRA IN THE DECAYS $Bi^{205} \rightarrow Pb^{205}$ AND $Bi^{206} \rightarrow Pb^{206}$. J. H. Brunner (Eidgenössische Technische Hochschule, Zurich), R. Lombard, C. F. Perdrisat, and H. J. Leisi. Helv. Phys. Acta, 34: 472-7 (1961). (In French)

The positron decay spectra of Bi^{205} and Bi^{206} were measured using a magnetic lens spectrometer with an electron pair separator. The results for five transitions in Bi^{206} and four transitions in Bi^{205} are shown graphically. The half life of Bi^{205} was determined to be 15.31 ± 0.04 days and that of Bi^{206}, 6.243 ± 0.003 days. In Bi^{205} internal pair transitions were found at 1766, 1777, 1863, and 1906 kev. In Bi^{206} three new transitions were found at 1845, 1880, and 1903 kev. (J.S.R.)

7047 BETA-GAMMA ANGULAR CORRELATIONS IN THE DECAY OF Eu^{154}. J. W. Sunier (Eidgenössische Technische Hochschule, Zurich). Helv. Phys. Acta, 34: 477-9(1961). (In French)

The directional correlation function of the β_1-γ_1 cascade in the decay of Eu^{154} into Gd^{154} was measured as a function of the energy of the beta particle. The measured correlation function, corrected for the finite dimensions of the detectors, the presence of accidental coincidences, and γ-γ and β-γ coincidences of other cascades in the energy region below 1600 kev, is shown graphically. The results are compatible with the K prohibition rule. (J.S.R.)

7048 (n,t) PROCESSES IN MEDIUM HEAVY NUCLEI. F. Heinrich and F. Tanner (Eidgenössische Technische Hochschule, Zurich). Helv. Phys. Acta, 34: 481-3(1961). (In German)

In order to decide whether (n,t) processes proceed by a compound state or must be treated as direct processes, the total (n,t) cross sections were measured for Al, Cr, Mn, Fe, Co, Ni, Cu, and Ag. The results were compared with those obtained on the basis of a compound state process. In all the elements but Ag there was a satisfactory agreement between theory and experiment. However, the discrepancy with respect to Ag suggests that Ag(n,t) must proceed by another reaction mechanism. (J.S.R.)

7049 INELASTIC SCATTERING OF 14-MEV NEUTRONS ON LEAD, MERCURY, AND URANIUM. P. Niklaus, P. Huber, and R. Wagner (Universität, Basel). Helv. Phys. Acta, 34: 520-41(1961). (In German)

A (d,t)-neutron source was pulsed to measure the flight time of scattered neutrons. A simple deflecting device for

ions of small velocities is described, that allows the production of neutron bursts of 2 ns duration. The energy distribution in the region between 1 and 4 Mev of 14.5 Mev-neutron scattered from natural Pb, Pb^{206}, and Hg was investigated. After corrections for (n,2n) processes according to Lang and LeCouteur the following nuclear temperatures resulted: Pb, 1.06 Mev; Pb^{206}, 0.98 Mev; and Hg, 0.8 Mev. The energy spectrum of neutrons emitted by irradiated natural U was also determined. This distribution deviates significantly from that of the other elements investigated because of the contribution of fission neutrons. (auth)

7050 ENERGY LEVELS OF C^{12} FROM $Be^9(\alpha,n\gamma)C^{12}$ REACTION. Tahir Husain (Government Coll., Lahore, West Pakistan) and F. V. Price. J. Nat. Sci. and Math., 1: No. 2, 1-6(Oct. 1961). (In English)

Energy levels of C^{12} were studied by examining gamma radiation from the reaction $Be^9(\alpha,n\gamma)C^{12}$, using a scintillation pair spectrometer with differential discriminators in the side channels. Gamma rays of 3.14 ± 0.05 Mev with intensity ~2%, relative to the 4.43 Mev gamma rays from the same reaction, were detected. This establishes the energy of the level in C^{12} as 7.5 ± 0.1 Mev. The region in the neighborhood of 7.5 Mev was also examined but no evidence was found for a radiation of this energy which, together with other evidence suggests that the spin of this level is J = 0 from which the ground state transition (J = 0 for the ground state) is forbidden. (auth)

7051 ENERGY LEVELS OF N^{14} FROM $C^{13}(p,\gamma)N^{14}$ REACTION. Tahir Husain (Government Coll., Lahore, West Pakistan) and F. V. Price. J. Nat. Sci. and Math., 1: No. 2, 7-17(Oct. 1961). (In English)

Proton capture by C^{13} exhibits a well known resonance at 554 kev. Gamma rays from this reaction were first studied with a scintillation pair spectrometer without differential discriminators in the side channels. To check the previous results from this reaction, the whole gamma spectrum was studied using a single-crystal spectrometer. The radiations from the reaction were reinvestigated with the three-crystal pair spectrometer with differential discriminators in the side channels to detect possible transitions between levels hitherto undetected as a result of limited resolving power of the single-crystal spectrometer. (auth)

7052 DECAY OF Sr^{83}. Tokihiro Kuroyanagi (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Japan, 16: 2363-8(Dec. 1961). (In English)

The disintegration of Sr^{83} produced by (γ,n) reaction was studied using a scintillation spectrometer. The gamma spectra showed lines at 40, 385, and 755 kev. Analysis of the beta spectra defined two groups of beta rays of endpoint energies 0.81 and 1.15 Mev. The decay scheme was proposed from the information of the single and coincidence scintillation spectra. In the decay scheme, the 40-, 385- and 755-kev levels were established and the spin and parity assignments of ground and first excited 40-kev levels were confirmed to be $^5/_2-$ and $^3/_2-$, respectively. (auth)

7053 DECAY OF As^{79}. Tokihiro Kuroyanagi (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Japan, 16: 2369-71(Dec. 1961). (In English)

As^{79} was produced by a strong bremsstrahlung from a linear electron accelerator. It was separated chemically from SeO_2 irradiated by the bremsstrahlung. The decay of As^{79} was studied with the aid of scintillation spectrometers. From the information of the gamma and beta spectra and of the coincidence measurements, the decay scheme of As^{79} was proposed. (auth)

7054 ISOMERIC CROSS SECTION RATIOS FOR 14 Mev NEUTRON REACTIONS. Fumio Fukuzawa (Hyōgo Univ. of Agriculture, Japan). J. Phys. Soc. Japan, 16: 2371-8(Dec. 1961). (In English)

The cross sections for the production of isomeric pairs in the following reactions with 14-Mev neutrons were measured by the activation method using a sandwiched plastic scintillator: $As^{75}(n,p)Ge^{75}$(25 ± 5 mb), $As^{75}(n,p)Ge^{75m}$ (10 ± 2 mb); $Br^{81}(n,2n)Br^{80}$(470 ± 50 mb), $Br^{81}(n,2n)Br^{80m}$ (510 ± 50 mb); $Ba^{138}(n,\alpha)Xe^{135}$(13 ± 2 mb), $Ba^{138}(n,\alpha)Xe^{135m}$ (13 ± 2 mb); $Ho^{165}(n,p)Dy^{165}$(40 ± 10 mb), $Ho^{165}(n,p)Dy^{165m}$ (<1 mb). Their isomeric cross section ratios are compared with the statistical model calculations based on the method of angular momentum sampling. For $Br^{81}(n,2n)$ and $Ba^{138}(n,\alpha)$ reactions, these ratios can be reproduced by these calculations with the value of the level density parameter $\sigma = 4 \pm 1$, but not for the other two. The disagreement in $As^{75}(n,p)$ reaction can be explained by the predominance of the direct interaction process. (auth)

7055 ANGULAR DISTRIBUTIONS OF ALPHA-PARTICLES FROM F^{19}, Al^{27}, AND P^{31} BOMBARDED WITH PROTONS. Sukeaki Yamashita (Kyoto Univ.). J. Phys. Soc. Japan, 16: 2378-85(Dec. 1961). (In English)

The angular distributions of alpha-particles were obtained for the reactions $F^{19}(p,\alpha)O^{16}$ leaving the residual nucleus in the ground state, $Al^{27}(p,\alpha)Mg^{24}$ and $P^{31}(p,\alpha)Si^{28}$ leaving the residual nuclei in the ground and first excited states at four bombarding energies between 6.0 and 7.4 Mev. The angular distribution for the reaction $F^{19}(p,\alpha)O^{16}$ shows the backward peak at each energy, but at small angles it depends on the bombarding energy. The angular distributions for the reactions $Al^{27}(p,\alpha)Mg^{24}$ and $P^{31}(p,\alpha)Si^{28}$ are also energy-dependent, but contain a larger isotropic part than those for the reaction $F^{19}(p,\alpha)O^{16}$. The integrated cross sections for the reactions $Al^{27}(p,\alpha)Mg^{24}$ and $P^{31}(p,\alpha)Si^{28}$ leaving the residual nuclei in the first excited states are several times as large as those for the reactions leaving the residual nuclei in the ground states. It appears unlikely that these reactions can be accounted for by the formation of compound nucleus or by simple direct interaction. The possible mechanisms through which these reactions may take place are discussed. (auth)

7056 GAMMA RAYS FROM THE PROTON BOMBARDMENT OF P^{31} AND THE EXCITED STATES OF P^{31}. Tetsuo Wakatsuki, Yasuo Hirao, Eiji Okada, and Iwao Miura (Osaka Univ.). J. Phys. Soc. Japan, 16: 2385-92(Dec. 1961). (In English)

Gamma rays from P^{31} bombarded by protons of up to 5.7-Mev energy were analyzed by scintillation spectrometers. Most of the observed gamma rays were attributed to transitions from excited states of P^{31} produced by the inelastic scattering of protons. Gamma transition branching ratios from excited states were determined. The results are in general agreement with the results obtained from the experiments on $Si^{30}(p,\gamma)P^{31}$ reaction, but differences between them are discussed in detail. It was noted that the gamma ray of 1.65-Mev energy resulting from the transition from the excited state at 4.784-Mev to the 3.133-Mev state is emitted in considerable intensity at the proton bombarding energy of 5.7 Mev. It was suggested that this selective excitation might be the result of the collective nature for the 4.784-Mev excited level. Excitation curve for the gamma intensity gave the compound levels of S^{32} at 13.61, 13.97, and 14.27 Mev. (auth)

7057 NEW ACTIVITIES IN RARE EARTH REGION PRODUCED BY THE (γ,p) REACTIONS. Tokihiro Kuroyanagi, Haruo Yuta, Kasuke Takahashi, and Haruhiko

Morinaga (Tôhoku Univ., Sendai). J. Phys. Soc. Japan, 16: 2393-2401(Dec. 1961). (In English)

New activities in the rare earth region were identified and decay characteristics of previously reported activities in this region were studied in more detail. They were produced by the (γ,p) reactions and measurement was made using scintillation spectrometers. Results were as follows:

nuclides	half lives	beta rays	gamma rays
Eu^{159}	19.0 ± 1.0 min	2.2 ± 0.1 Mev	(45, 170 kev)
Tm^{173}	7.3 ± 0.5 hr	0.90 ± 0.05 Mev	400, 470 kev
Tm^{175}	20 min	2.0 Mev	510 kev
Lu^{178}	30 ± 5 min	2.25 ± 0.05 Mev	none
Lu^{178m}	16 min	1.50 ± 0.05 Mev	60, 90, 215, 325, 425 kev
Lu^{179}	7.5 ± 0.5 hr	1.35 ± 0.05 Mev	90, 215 kev

Analyses were made using the unified model. (auth)

7058 QUADRUPOLE COUPLING IN THE HYPERFINE STRUCTURE OF THE SPECTRUM OF La I. Kiyoshi Murakawa (Tokyo Univ.). J. Phys. Soc. Japan, 16: 2533-7(Dec. 1961). (In English)

According to the theory of Sternheimer, it can be written $Q = (1 + \Delta)Q'$, in which Q is the true quadrupole moment and Q′ is the apparent quadrupole moment obtained by spectroscopic means neglecting the shielding effect; Δ is the so-called shielding correction or core correction. It was shown that $\Delta = -0.6$ for $5d^26s^4F_{\frac{9}{2}}$ of La I. The values $\Delta = -0.6$ and -0.7 were obtained for $5d^26s^4F_{\frac{9}{2}}$ and $^4F_{\frac{7}{2}}$ respectively of La I. They agree with the value for $^4F_{\frac{9}{2}}$ within experimental error. (auth)

7059 $O^{16}(d,\alpha)N^{14}$ REACTION WITH DEUTERONS NEAR 15 MeV. Takuji Yanabu, Sukeaki Yamashita, Teruo Nakamura, Kunio Takamatsu, Akira Masaike, Shigeru Kakigi, Dai Ca Nguyen, and Kiyohiko Takimoto (Kyoto Univ.). J. Phys. Soc. Japan, 16: 2594-5(Dec. 1961). (In English)

Angular distributions of alpha particles from the $O^{16}(d,\alpha)N^{14}$ reaction were measured. Results from the ground-state and second-excited-state reactions are presented in graphical form. The absolute cross section calculated from $C_8H_4O_2$ agreed reasonably with that from the O_2 gas target. The principle of isotopic spin conservation was violated in this reaction. Comparison is made with previous experiments (T. Yanabu, J. Phys. Soc. Japan 16, 2118(1961); NSA, 15: 21556; NSA, 15: 26972). (L.N.N.)

7060 THE DECAY OF Ce^{144}. J. S. Geiger, R. L. Graham, and G. T. Ewan (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nuclear Phys., 28: 387-406(1961). (In English)

The results of conversion electron-gamma and gamma-gamma coincidence studies of the Ce^{144} decay are presented. The gamma-ray spectra studied include those coincident with the L_I 33.57, L_I 40.93, K 80.12, L_I 80.12, K 133.53, and L_I 133.53-kev conversion lines and with γ 80.12, γ 133.53, and the Pr KX-rays. A detailed search of the conversion electron spectrum for the K line of a 66-kev transition is reported. This search gave a negative result; the intensity of such a line is <5% of that of the L_I 33.57 conversion line. These new experiments provide both qualitative and quantitative support for the Ce^{144} disintegration scheme previously reported which was deduced from a high-resolution investigation of the Ce^{144} internal conversion electron spectrum. The results do not support modifications to this scheme which were recently proposed by four experimental groups. The conversion electron-coincidence results limit the intensity of a β feed to the 99.95-kev level in Pr^{144} to <0.3% per disintegration. (auth)

7061 CONCERNING THE EXISTENCE OF RARE LIGHT NUCLEI. Nelson Jarmie (Los Alamos Scientific Lab., N. Mex.). Nuclear Phys., 28: 426-7(1961). (In English)

Excellent agreement is obtained in a comparison of experimental results with the predictions of A. I. Baz' (Atomnaya Energiya 6, 571(1959); 6, 422(1960); J. Nuc. Ener.: A 13, 74(1960)) concerning the masses of rare light nuclei with a large neutron or proton excess. (auth)

7062 ELASTIC SCATTERING OF PROTONS BY ARGON-36. C. C. Kim (State Univ. of Iowa, Iowa City) and A. C. L. Barnard. Nuclear Phys., 28: 438-42(1961). (In English)

Absolute differential cross sections for the elastic scattering of protons by Ar^{36} were measured for laboratory proton energies from 1.0 to 1.8 Mev at a center-of-mass angle of 158.4°. The cross sections are equal to the Rutherford value except in an anomalous region near $E_p = 1.494$ Mev, corresponding to a level in K^{37} with 3.34-Mev excitation. Cross sections were measured as a function of energy at angles $\theta_{CM} = 90.0°$, 125.3°, and 160.1° over the anomalous region, and an angular distribution was taken at $E_p = 1.494$ Mev. The data were analyzed in terms of dispersion theory to assign $j^\pi = \frac{1}{2}-$ to the K^{37} state. (auth)

7063 THE 9.63 Mev STATE OF C^{12}. Richard R. Carlson (State Univ. of Iowa, Iowa City). Nuclear Phys., 28: 443-55(1961). (In English)

Gamma radiation from the 16.11-Mev state to the 9.63-Mev state in C^{12} was identified with a three-crystal pair spectrometer and with 15 cm long by 12.7 diameter NaI(Tl) crystal detectors. The 6.45 ± 0.05-Mev line occurs with a branching ratio of 1% of the well-known 11.67 to 4.43-Mev cascade radiation. The 16.11-Mev state of C^{12} was obtained by bombardment of thick boron targets with protons at the 163-kev resonance for the B^{11} + p reaction. The yield of 6.45-Mev radiation showed resonance at the same energy as the cascade radiation. Coincidence spectra taken with two detectors, biased at 1.0 Mev, showed that less than 2.5% of the 6.45-Mev radiation is accompanied by gamma radiation, in agreement with the known alpha decay of the 9.63-Mev state. The angular distribution of the 6.45-Mev radiation was measured. It is only consistent with a spin and parity of 3- for the 9.63-Mev state, when taken with the known alpha decay. (auth)

7064 LEVELS IN A^{38} OBSERVED THROUGH THE $Cl^{37}(p,n)A^{37}$ REACTION NEAR THRESHOLD. G. S. Mani, A. C. L. Barnard, T. A. Tombrello (Rice Univ., Houston, Tex.) and D. A. A. S. N. Rao. Nuclear Phys., 28: 456-63 (1961). (In English)

Thin Cl^{37} targets were bombarded with monoenergetic protons, the over-all proton energy resolution being about 1.7 kev. A long counter was used to observe neutrons from the $Cl^{37}(p,n)Ar^{37}$ reaction at energies up to 0.8 Mev above the reaction threshold. The widths and spacings of 91 resonances were measured. A gross structure was discerned, believed to be related to a neutron independent-particle state near the neutron separation energy. (auth)

7065 GROSS PROPERTIES OF LEVELS IN A^{38} WITH EXCITATION NEAR NEUTRON SEPARATION ENERGIES. A. C. L. Barnard, G. S. Mani, and P. D. Forsyth. Nuclear Phys., 28: 464-70(1961). (In English)

Cl^{37} targets of the order of 100-kev thick to 2 Mev protons were bombarded with monoenergetic protons. Neutron detectors sensitive to neutron energy were used to observe

and distinguish between neutrons from the reactions $Cl^{37}(p,n)Ar^{37}$ and $Cl^{37}(p,n)Ar^{37*}$, where Ar^{37*} refers to the first excited state of Ar^{37}. Compared to a Hauser-Feshbach statistical calculation, the yield N_0 from the ground-state reaction is anomalous, showing a broad maximum centered about 0.5-Mev above the reaction threshold. A further broad maximum in N_0 is seen about 0.5 Mev above the threshold for the excited state reaction, and in this region there is also a broad maximum in the yield N_1 from the excited state reaction. The yields N_0 and N_1 behave somewhat similarly up to about 1 Mev above the respective thresholds. (auth)

7066 MEASUREMENTS OF INTERNAL CONVERSION COEFFICIENTS. Soelve Hultberg, Daniel J. Horen, and Jack M. Hollander (Univ. of California, Berkeley). Nuclear Phys., 28: 471-7(1961). (In English). (UCRL-9608(Rev.))

Internal conversion coefficients of M1, M4 and E2 transitions from the Y^{87}, Cs^{137}, Au^{198}, and Ir^{192} decays have been studied by using the internal-external conversion (IEC) method. For unhindered transitions of the $2+ \rightarrow 0+$ type it is found $(\alpha_2)_{317} = 0.054 \pm 0.003$ for the 317-kev transition from Ir^{192} and $(\alpha_2)_{412} = 0.028 \pm 0.0015$ for the 412-kev transition from Au^{198}, the theoretical values being 0.054 and 0.030, respectively. (auth)

7067 DISINTEGRATION OF K^{39} BY FAST NEUTRONS. R. Bass, H. P. Haeeni, T. W. Bonner, and F. Gabbard (Rice Univ., Houston, Tex.). Nuclear Phys., 28: 478-93(1961). (In English)

The nuclear reactions $K^{39}(n,p)Ar^{39}$ and $K^{39}(n,\alpha)Cl^{36}$ were studied by bombarding a KI(Tl) crystal with mono-energetic fast neutrons and observing scintillations due to emitted protons and α particles. Using good energy resolution (less than 10 kev) a yield curve was obtained for the p_0-group for neutron energies from 1.46 to 3.05 Mev, which exhibits 60 narrow resonances. Measurements with poorer energy resolution, varying between 70 and 150 kev, were made in the neutron energy region from 2.3 to 8.7 Mev. From these absolute values of the reaction cross sections for the p_0-group (E_n = 2.3 to 8.7 Mev), the α_0-group (E_n = 2.3 to 3.8 Mev) and the p_1-group (E_n = 2.5 to 3.5 Mev) were extracted. Fourteen proton groups are seen in the pulse-height spectra, and from an analysis of the associated pulse-heights as a function of neutron energy, ten new excited states of Ar^{39} were derived. The measured cross sections are compared with values obtained by other groups and with theoretical predictions. (auth)

7068 NEUTRON THRESHOLD MEASUREMENTS IN THE REACTIONS $^9Be(p,n)^9B$, $^{10}B(p,n)^{10}C$, $^{11}B(p,n)^{11}C$. S. Takayanagi, N. H. Gale, J. B. Garg, and J. M. Calvert (Univ. of Manchester, Eng.). Nuclear Phys., 28: 494-502 (1961). (In English)

Neutron thresholds resulting from proton bombardment of Be^9, B^{10}, and B^{11} were investigated by the use of the counter ratio method, in the range of proton energies from 3 to 5.5 Mev. The ground state threshold energy for the $B^{10}(p,n)C^{10}$ reaction was found to be (4.835 ± 0.025) Mev, corresponding to a mass excess for C^{10} of (18.620 ± 0.025) Mev. An expected low lying excited state threshold for the $Be^9(p,n)B^9$ reaction at about 3.8 Mev was not found, and the first excited state threshold for the $B^{11}(p,n)C^{11}$ reaction was not found up to 5.2 Mev bombarding energy. (auth)

7069 ON THE LEVELS AND TRANSITIONS IN Gd^{155}. B. N. Subba Rao (Tata Inst. of Fundamental Research, Bombay). Nuclear Phys., 28: 503-11(1961). (In English)

Gamma-gamma coincidences of transitions in Gd^{155} were studied. The (45-kev gamma)-(60-kev gamma) angular correlation was measured and could be represented by $W(\theta) = 1 + (0.155 \pm 0.016) P_2(\cos\theta) + (0.028 \pm 0.025) P_4(\cos\theta)$, which requires, together with the other properties of the 60-kev transition, $\frac{3}{2}^+$ assignment to the 105-kev level. This is identified with the $\frac{3}{2}^+$ [651] orbital in the Mottelson-Nilsson classification. The mixing ratio of the 45-kev transition is found to be $\delta_1^2 = M_2/E1 = 0.0074$ ($\delta_1 = +0.086$) with the mixing ratio of the 60-kev transition of $\delta_2^2 = E2/M1 = 0.04$ ($\delta_2 = -0.20 \pm 0.03$). A level scheme based on these studies is presented and the properties of levels and transitions are discussed. (auth)

7070 MULTIPLE COULOMB SCATTERING FROM FINITE NUCLEI. M. A. Meyer (Potchefstroom Univ. for C.H.E., Potchefstroom, S. Africa). Nuclear Phys., 28: 512-18(1961). (In English)

A general expression is derived for the multiple Coulomb scattering of charged particles by finite nuclei. This expression is valid for any charge distribution in the nucleus. The general expression is integrated by assuming Olbert's form factor and more realistic ones. (auth)

7071 EXCHANGE STRIPPING EFFECTS IN THE REACTION $B^{11}(d,n)C^{12}_{4.43}$. R. A. Zdanis (Princeton Univ., N. J.), C. A. Bruns, G. E. Owen, L. Madansky, and S. Edwards. Nuclear Phys., 28: 550-9(1961). (In English)

Angular distributions for the $B^{11}(d,n)C^{12}$ reaction leading to the 4.43-Mev level are presented for bombarding energies of 1.1, 2.5, and 2.8 Mev (Lab.). These distributions are fitted with a two-mode stripping theory. This theory with all parameters fixed is used to fit n-γ correlations at 1.1 Mev and published data at 2.65 Mev. It is suggested that the discrepancies which still remain between theory and experiment may be reconciled by using a distorted wave Born approximation to the two-mode theory. (auth)

7072 CROSS-SECTIONS FOR (n,2n) REACTIONS AT 14.8 Mev. C. S. Khurana and H. S. Hans (Muslim Univ., Aligarh, India). Nuclear Phys., 28: 560-9(1961). (In English)

Total cross sections for (n,2n) reactions were measured at 14.8-Mev neutron energy for more than twenty cases by the activation method. Discrepancies were found in some cases from the published values. Also a number of new cases were measured. The observed values were compared with those calculated on the statistical model using level density formulas of Lang and Le Couteur, and Newton. Comparison of the calculated and observed cross-sections gives an indication that at least part of the (n,2n) reaction goes through some mechanism other than the formation of the compound nucleus. (auth)

7073 "SELF-SCINTILLATION" STUDY OF THE BETA DECAY OF Rb^{87}. G. B. Beard (Wayne State Univ., Detroit) and W. H. Kelly. Nuclear Phys., 28: 570-7(1961). (In English)

The beta decay of Rb^{87} was studied using the self-scintillations produced in three NaI(Tl) crystals doped with rubidium. The beta spectrum was measured down to 5 to 8 kev. An end point energy of 274 ± 3 kev and a specific activity equal to 780 ± 14 sec^{-1} per gram of natural rubidium were found. Assuming an isotopic abundance of 27.85% for Rb^{87}, a half life of (5.53 ± 0.10) × 10^{10} yr is obtained. (auth)

7074 THE SECOND-ORDER OPTICAL POTENTIAL FOR PION-NUCLEUS SCATTERING. Robert R. Johnston (Los Alamos Scientific Lab., N. Mex.) and Kenneth M. Watson. Nuclear Phys., 28: 583-97(1961). (In English)

The optical model for high energy elastic scattering of pions by nuclei may be explicitly evaluated in terms of two-nucleon correlations in nuclei (neglecting tertiary and higher order correlations), using dispersion relations to

give the relevant scattering amplitudes. Previous treatments of the effects of pair correlations have assumed specific nuclear models. It is shown how this may be done avoiding model-dependent assumptions. (auth)

7075 A SURVEY OF GAMMA RAY BRANCHING RATIOS. William W. Pratt (Pennsylvania State Univ., University Park). Nuclear Phys., 28: 598-601(1961). (In English)

Experimental gamma branching ratios are compared with the predictions of the single particle model. When both transitions are predicted to be predominantly E1 or M1 the experimental branching ratios show a distribution which is centered close to the predicted value with 69 to 76% of the transition pairs within a factor of 10 and 92 to 94% within a factor of 100 of this. When one transition is predicted to be E2 and the other M1, the median E2-M1 branching ratio is 63 times the predicted value with a spread similar to that of the E1-E1 and M1-M1 distributions. (auth)

7076 ANOMALOUS ELECTRIC-DIPOLE INTERNAL CONVERSION. E. L. Church (Frankford Arsenal, Philadelphia) and J. Weneser. Nuclear Phys., 28: 602-23(1961). (In English)

A group of highly forbidden electric-dipole transitions in the heavy-element region are known to exhibit anomalous internal conversion. These transitions are close to or below the threshold for K conversion. Their L and M subshell conversions show anomalies which exhibit a definite pattern: L_I and L_{II} subshell conversion is enhanced relative to the corresponding "book" values, while L_{III} is approximately normal. This pattern is explained in terms of "penetration" nuclear matrix elements for internal conversion, which arise because of the penetration of the converting atomic electron within the nucleus. It is found that for E1 transitions there are two types of penetration matrix elements. One of these, $\int_0 \cdot \hat{r}\gamma^2 Y_1^*$, gives an important contribution only to $s_{1/2} \nrightarrow p_{1/2}$ electron transitions. Such electron transitions are present in L_I and L_{II} conversion, but are absent in L_{III} conversion. Since calculations based on approximate nuclear models indicate that this matrix element is much larger than other penetration matrix elements, a ready qualitative explanation of the experimental results for the three L subshells is available. Similar results are expected for the M subshells, etc. Quantitative interpretation of the observed conversion anomalies evaluates the nuclear penetration matrix elements. These matrix elements contain information in addition to that contained in the gamma-ray matrix element. (auth)

7077 OPTICAL GIANT RESONANCES IN NUCLEAR REACTIONS. Karl Wildermuth (Florida State Univ., Tallahassee and Oak Ridge National Lab., Tenn.) and Robert L. Carovillano. Nuclear Phys., 28: 636-48(1961). (In English)

Physical reasons for optical giant resonances being a very general feature of nuclear reactions are discussed. Optical giant resonances, so familiar in the scattering of nucleons on nuclei, were also observed in elastic cross sections of composite particles scattered by nuclei and in reaction channels of a compound nucleus decay. That this optical giant resonance structure should be expected to occur in such a variety of nuclear reactions is mainly attributed, in our arguments, to the effect of the indistinguishability of the nucleons on the interaction between two proximate nuclear clusters. Because of the indistinguishability of the nucleons, the lifetime of the nuclear clusters in a compound nuclear state can often be prolonged to times, of order 10^{-20} to 10^{-22} sec, of sufficient duration compared to the transit times to account for the observed resonances. The relationship of the giant resonance structure and the Coulomb barrier is also discussed. (auth)

7078 THE NUCLEUS Y^{88} AND THE $Y^{88}-Sr^{88}$ MASS DIFFERENCE. S. M. Shafroth (Franklin Inst., Swarthmore, Penna.). Nuclear Phys., 28: 649-61(1961). (In English)

The $Y^{88}-Sr^{88}$ mass difference was determined by measuring threshold energies for $Sr^{88}(p,n)Y^{88}$ (4454 ± 6) kev and $Sr^{88}(p,n)Y^{88*}$ (γ) (4848 ± 6) kev. The latter value when combined with the determination of the Y^{88*} (γ) energy (393 ± 1) kev leads to a ground state threshold energy of 4450 ± 6 kev. These measurements result in an $Y^{88}-Sr^{88}$ mass difference of 3619 ± 6 kev. In order to understand a 200-kev discrepancy between the (p,n) threshold energy and the $Y^{88}(\beta^+)Sr^{88*}$ end-point energy, searches were made for a (p,n) threshold at bombarding energies of 4.1 to 4.45 Mev, but none was found. A search was also made for a γ-ray in the neighborhood of 200 kev. No evidence for new states in Y^{88} or Sr^{88} was found. Comparison with experiment of theoretical capture-to-positon ratios for the transition from Y^{88} to the 1837-kev state of Sr^{88} based on the above mass difference and a study of log ft values for this transition favor spin and parity assignments of 4- and 1+ for the Y^{88} ground and first excited states, respectively. (auth)

7079 ANGULAR DISTRIBUTION OF PHOTOPROTONS FROM DEFORMED NUCLEI. Torsten Gustafson (Inst. of Theoretical Physics, Lund, Sweden). Nuclear Phys., 28: 665-80(1961). (In English)

The angular distribution of photoprotons emitted from deformed nuclei may be anisotropic because of several processes. The coupling of the angular momentum of the parent nucleus with those of the daughter nucleus and the emitted proton is very important for the distribution. Furthermore, the surface value of the proton wave function may vary strongly from the pole to the equator of the deformed nucleus. The proton while passing the Coulomb barrier 'feels' the anisotropy and exchanges angular momentum with the nucleus to a considerably smaller degree than an α-particle, especially with light nuclei. Angular distributions, illustrating these effects, are given for Mg^{24} and Np^{234}. Further, we approach the classical case of fixed axes, where the influence of the surface values of a proton wave function clearly exhibits itself. The total decay probabilities for the deformed nuclei considered deviate only slightly from those of a spherical nucleus, namely by factors between 0.84 and 1.25. (auth)

7080 THE AVERAGE NUMBER OF BETA DECAYS FOR EACH FISSION OF A U^{236} NUCLEUS AS A FUNCTION OF TIME. Guenther Alzmann (Technische Hochschule, Munich). Nukleonik, 3: 295-301(Dec. 1961). (In German)

The number of beta particles which in the time t after the fission of a U^{236} nucleus will be emitted, on the average, was determined directly. For this it was observed how the beta activity in a uranium layer of about 50 mg/cm^2 increased during irradiation with thermal neutrons. Up to an hour after fission, 4.4 ± 0.5 beta decays were measured for each fission. The stated error is the sum of the systematic and statistical error. The graphical integration of the calculated value of beta activity between one hour and 100 yr yielded 2.2 ± 0.4 beta decays for each fission of a U^{236} nucleus. With the help of the chain yield and the nuclear charge of the stable end products of the fission, a value of 6.3 beta decays per fission was calculated. The following values were inferred from these results: at 0 to 0.5 sec, $\beta(t) = 0.7e^{-1.6t}$; at 0.5 to 30 sec, $\beta(t) = 0.23t^{-0.66}$; and at 30 sec to 10 days, $\beta(t) = 1.2t^{-1.14}$ where t is in sec-

onds. The agreement with earlier measurements was good. (tr-auth)

7081 THE EFFECTIVE RESONANCE INTEGRAL OF GOLD FOIL. Arnold E. Gruen (Siemens-Schuckertwerke A. G., Garching, Ger.). Nukleonik, 3: 301-3(Dec. 1961). (In German)

The effective resonance integral of gold foil was measured relative to the resonance integral of gold of infinite thinness. The ratio of the two resonance integrals, the "G-factor," was determined by the activity of a deposit of varyingly thick foil which was activated in the same resonance flux. The foil thickness varied between 0.06 and 200 mg/cm^2. The results were compared with the theory of Männer and Springer. (tr-auth)

7082 CALCULATION OF RESONANCE INTEGRALS OF U^{238}. Albert Mueller (Siemens-Schuckertwerke A. G., Erlangen, Ger.). Nukleonik, 3: 303-8(Dec. 1961). (In German)

A previously developed theory was used for calculation of the resonance integral of U^{238} for various compositions of fuel elements and different temperatures. After a short discussion of theory the calculated results for U^{238} are given. The necessary steps in the calculation of these results are summarized. The theoretical values were compared with measured values. (tr-auth)

7083 PRESSURE DEPENDENCE OF THE MÖSSBAUER EFFECT. Russell V. Hanks (Boeing Scientific Research Labs., Seattle). Phys. Rev., 124: 1319-20 (Dec. 1, 1961).

The pressure dependence of the Mössbauer effect is examined and expressions are given (in the Debye approximation) for the probability of recoilless emission (absorption) as a function of the specific volume. It is concluded that the effect of pressure is slight for metals such as Zn, Sn, etc., but that more compressible elements should exhibit observable pressure dependencies at moderate pressures. A calculation is given which predicts that the recoilless emission of the 81-kev line in Cs^{133} should become observable at a pressure of about 5000 atm. Additional experiments involving the above pressure dependence are also discussed. (auth)

7084 NUCLEAR QUADRUPOLE COUPLING CONSTANT OF Be^9 IN BeO. J. F. Hon (Atomics International, Canoga Park, Calif.). Phys. Rev., 124: 1368-72(Dec. 1, 1961).

From the splitting of the nuclear magnetic resonance line in polycrystalline BeO, the quadrupole coupling constant of Be^9 in BeO was determined to be 41 ± 4 kc/sec with zero asymmetry parameter. Effects of anisotropic distribution of crystallites were observed and used in the analysis of the data. (auth)

7085 PARAMAGNETIC RESONANCE OF TRIVALENT Pm^{147} IN LANTHANUM ETHYL SULFATE. H. J. Stapleton, C. D. Jeffries, and D. A. Shirley (Univ. of California, Berkeley). Phys. Rev., 124: 1455-7(Dec. 1, 1961).

Paramagnetic resonance absorption at 3-cm wavelengths is observed for trivalent Pm^{147} in a single crystal of lanthanum ethyl sulfate at 4.2°K. The observed spectra correspond to eight hfs transitions of a system described by the spin Hamiltonian $\mathcal{H} = g_{||}\beta H_z S_z + A I_z S_z + \Delta_x S_x + \Delta_y S_y$, with $S = \frac{1}{2}$, $I = \frac{7}{2}$, $|g_{||}| = 0.432 \pm 0.004$, and $|A|/h = 496.6 \pm 4$ Mc/sec. The value of $\Delta = (\Delta_x^2 + \Delta_y^2)^{1/2}$ is not directly measured in this experiment but is known from nuclear alignment to be $\Delta/k = 0.02 \pm 0.01$°K. The line shapes exhibit an asymmetry typical of non-Kramers doublets and become unobservable in a few days presumably due to broadening from radiation damage to the crystal. The experimental value of $g_{||}$ is found to be in reasonable agreement with that predicted from crystal field theory. Effects from higher J level admixtures are taken into account in estimating the nuclear magnetic moment value $|\mu(Pm^{147})| = 3.0 \pm 0.3$ nm. (auth)

7086 PROTON RADIO-FREQUENCY SPECTRUM OF HCl^{35}. John A. Leavitt, Milton R. Baker, H. Mark Nelson, and Norman F. Ramsey (Harvard Univ., Cambridge, Mass.). Phys. Rev., 124: 1482-86(Dec. 1, 1961).

The radio-frequency spectrum corresponding to reorientation of the proton magnetic moment in HCl^{35} in the presence of an external magnetic field was obtained using the molecular beam magnetic resonance method. From the observed resonance shapes and positions, the value of the spin rotational constant of the proton in HCl^{35} was determined to be $|c_p| = 41 \pm 3$ kc/sec. Due to the large quadrupole interaction in HCl^{35}, the perturbation methods of data analysis used with the HF molecule were inapplicable. An approximate theory of the proton spectrum was developed in detail to aid in the analysis of the experimental data in this case and in cases of similar intermediate coupling. Theoretical spectra were calculated on the UNIVAC computer using this approximate theory and directly compared with the experimental spectrum to estimate the value of $|c_p|$. Theoretical spectra were also calculated on the UNIVAC using a direct solution of the Hamiltonian secular equation and were compared with the experimental curves to provide a check on the validity of the approximate theory. The comparisons indicate that the use of the approximate theory will allow the determination of $|c_p|$ to within 10%. (auth)

7087 INFLUENCE OF THE ROTATIONAL LEVELS ON THE SCATTERING OF SLOW NEUTRONS BY GASEOUS METHANE. George W. Griffing (Phillips Petroleum Co., Idaho Falls, Idaho). Phys. Rev., 124: 1489-93(Dec. 1, 1961).

The partial differential cross section for gaseous methane is computed at incident neutron energies of 0.015 and 0.0252 ev at scattering angles of 16.3 and 26.0°. It is found that the quantum nature of the rotational levels has a marked effect on the scattering of neutrons. By comparing the results of these computations with the results of the experiments, it is demonstrated that this effect is also observed in the experiments. (auth)

7088 COMPARISON OF ALPHA-PARTICLE ENERGIES FROM VARIOUS Po^{210} SOURCES. C. P. Browne (Univ. of Notre Dame, Ind.) and T. A. Eastwood. Phys. Rev., 124: 1494-6(Dec. 1, 1961).

A comparison of the energies of alpha particles from six different Po^{210} sources was made with the same broad-range spectrograph used for a recent comparison of the Po^{210} alpha-particle energy with the $Li^7(p,n)Be^7$ threshold energy. The sources were prepared by different techniques and some were on flat backings whereas others were on cylindrical backings. It is concluded that the discrepancies in the most recent measurements of the alpha energy do not arise from source preparation techniques but the lower values of the older measurements are perhaps caused by source aging. (auth)

7089 DISTORTION EFFECTS IN DEUTERON STRIPPING REACTIONS WITH LOW Q VALUES. W. R. Gibbs (Rice Univ., Houston, Tex.) and W. Tobocman. Phys. Rev., 124: 1496-9(Dec. 1, 1961).

A series of numerical calculations were carried out to verify the hypothesis that distortion effects become small for deuteron stripping reactions with low bombarding energy

when the Q value is sufficiently small. Results do not support this hypothesis. (auth)

7090 PROPERTIES OF NUCLEI WITH NEUTRONS AND PROTONS IN THE $1f_{\frac{7}{2}}$ SHELL. R. D. Lawson (Argonne National Lab., Ill.). Phys. Rev., 124: 1500-5 (Dec. 1, 1961).

Elliott's generating procedure is used to derive wave functions for nuclei in which the $1f_{\frac{7}{2}}$ level is filling with neutrons and protons. It is assumed that the low-lying states of these nuclei have well-defined isotopic spin and that the configuration is pure. This representation, which mixes states of different seniority, is used to calculate beta-decay transition probabilities, and magnetic-dipole and electric-quadrupole properties of nuclei. The results are in much better agreement with experiment than are those obtained by use of a seniority classification for the nuclear states. In particular, there is a K selection rule which explains the anomalously long half-life for the $Ca^{47} \rightarrow Sc^{47}$ and $Ca^{45} \rightarrow Sc^{45}$ beta decays. The theoretical electric-quadrupole matrix elements are too small by a factor of 3-5, and the theoretical M1 lifetimes too short by approximately a factor of 10. For three particles in the $1f_{\frac{7}{2}}$ level (Sc^{43}) or three neutrons in the $1g_{\frac{9}{2}}$ state, the eigenfunctions given by the generator formalism are found to be almost identical with those derived from a conventional shell-model calculation. (auth)

7091 DIFFERENTIAL CROSS SECTIONS OF THE $Be^9(Li^7,\alpha)B^{12}$ AND $Be^9(Li^6,\alpha)B^{11}$ REACTIONS. Russell K. Hobbie, C. W. Lewis, and J. M. Blair (Univ. of Minnesota, Minneapolis). Phys. Rev., 124: 1506-12 (Dec. 1, 1961).

Differential cross sections were measured for α particles from the reactions $Be^9(Li^6,\alpha)B^{11}$ and $Be^9(Li^7,\alpha)B^{12}$. These reactions were studied for the ground states, the first seven excited states of B^{11}, and the first four excited states of B^{12}. Absolute cross sections were measured by comparison with Rutherford scattering. The measurements were carried out for laboratory bombarding energies from 3.3 to 3.75 Mev. (auth)

7092 ANGULAR DISTRIBUTION OF ALPHA PARTICLES EMITTED BY ORIENTED Np^{237} NUCLEI. S. H. Hanauer, J. W. T. Dabbs, L. D. Roberts, and G. W. Parker (Oak Ridge National Lab., Tenn.). Phys. Rev., 124: 1512-17 (Dec. 1, 1961).

Np^{237} nuclei were aligned through the electric quadrupole and magnetic hyperfine couplings in $NpO_2Rb(NO_3)_3$, cooled to 0.2 to 4.2°K. A complete experiment, with rotatable monocrystalline sample, solid-state counter, thermometer, and goniometer, was enclosed in a copper container filled with He^3 gas and thermally attached to ½ mole of paramagnetic salt which could be cooled magnetically. The measured temperature dependence of the α-particle anisotropy gives $A < 0$, $P > 0$ for the signs of the hyperfine coupling constants in NpO_2^{++}. The α particles were observed to be emitted preferentially along the direction of the nuclear angular momentum vector. The results are consistent with $P-\pi$ bonding in the NpO_2^{++} ion and with Hill and Wheeler's prediction of the role of barrier penetration in α emission from nonspherical nuclei. (auth)

7093 STRUCTURE OF Sn^{120} AND THE EFFECT OF THE PAIRING CORRELATION ON THE REDUCTION OF E2 TRANSITION IN Sn^{118} AND Sn^{120}. Hidetsugu Ikegami (Tokyo Univ.) and Takeshi Udagawa. Phys. Rev., 124: 1518-25 (Dec. 1, 1961).

A new level scheme is proposed for Sn^{120}. The levels proposed are the 1.17, 2^+; 2.20, 4^+; 2.29, 5^-; and 2.49 Mev, 7^- levels, which is concluded from the revision of the order of the cascade transition from the upper levels; the revised order of radiations are 0.20, E2; 0.09, E1; 1.03, E2; and 1.17 Mev, E2. The transition probabilities of the 0.20- and 0.09-Mev gamma rays are also revised as 1.6×10^{-3} and 3.5×10^{-5} in units of a single-proton transition. A weak cross-over 1.12-Mev E3 transition is observed whose probability is also reduced by the factor of 1.5×10^{-1}. All the results of the present experiment together with other data are discussed in terms of the theory of Kisslinger and Sorensen. It is shown particularly that the striking reduction of the 0.26-Mev E2 transition in Sn^{118} as well as that of the 0.20-Mev E2 transition in Sn^{120} is explained as a consequence of the pairing correlation. (auth)

7094 DECAY OF THE Zn^{71} ISOMERS. T. T. Thwaites and W. W. Pratt (Pennsylvania State Univ., University Park). Phys. Rev., 124: 1526-31 (Dec. 1, 1961).

The decay of the Zn^{71} isomers was reinvestigated using scintillation counter techniques. Samples of enriched Zn^{70} were exposed to reactor neutrons. Gamma rays of 120 ± 5, 390 ± 10, 510 ± 5, 680 ± 20, 920 ± 10, 1120 ± 10, and 1630 ± 10 kev were found in the decay of the 2.45 ± 0.10-min isomer. A beta ray group to the ground state of Ga^{71} with energy of 2.61 ± 0.05 Mev was found from the 2-min isomer. Gamma rays of 390 ± 5, 490 ± 5, and 610 ± 5 kev were found to be in cascade in the 4.0 ± 0.1-hr isomer and to be fed by a single beta group of 1.46 ± 0.05 Mev. A decay scheme for the Zn^{71} isomers is proposed. (auth)

7095 DIFFERENTIAL CROSS SECTIONS FOR $(n,n'\gamma)$ REACTIONS IN SEVERAL NUCLEI. J. W. Boring and M. T. McEllistrem (Univ. of Kentucky, Lexington). Phys. Rev., 124: 1531-7 (Dec. 1, 1961).

Differential cross sections for the production of gamma rays by inelastic neutron scattering were measured and compared with the predictions of the statistical model, employing a diffuse surface complex potential to represent the neutron-nucleus interaction. Transitions have been observed in Mg^{24}, Mn^{55}, Fe^{56}, and Pb^{206}. Predictions of the statistical model were in good agreement with total $(n,n'\gamma)$ cross sections measured for first-excited state transitions in Fe^{56} and Mg^{24}, and in agreement with measured transition rates from the second and third excited states of Fe^{56}. Angular distributions for Mn^{55} transitions are consistent with recent spin assignments for the second and third excited states, but the comparisons of the measured and calculated total cross sections are not as satisfactory as the comparisons in Fe^{56} and Mg^{24}. (auth)

7096 NUCLEAR RESONANT ABSORPTION OF GAMMA RAYS BY Ca^{40}. A. C. Eckert and E. F. Shrader (Case Inst. of Tech., Cleveland). Phys. Rev., 124: 1541-8 (Dec. 1, 1961).

Ground-state gamma rays (E_γ = 10.3 Mev) emitted by excited Ca^{40} formed in the reaction $K^{39}(p,\gamma)Ca^{40}$ at E = 2.05 Mev were resonantly absorbed in calcium. Nuclear resonant absorption occurs when the absorber is placed at such an angle that the energy discrepancy upon emission and absorption of the gamma rays is restored by the Doppler shift resulting from the recoil velocity of the excited Ca^{40} nucleus. The gamma radiation is detected by a scintillation detector mounted behind an angle-defining collimator. The nuclear resonant absorption curve is obtained by observing the transmission through the absorber as the collimator is rotated through the resonant angle. The observed width, which is of the order of 0.8 degree, is a function of the angular divergence of the proton beam and the angular opening of the collimator. From the integral of the absorption as a function of angle and from a yield measurement, the radiation width for a transition to the ground state is determined to be 3.6 ± 0.24 ev, while 5.8 ± 1.8 ev is found for the proton width, and 10.3 ± 1.7 ev for the total width.

These values together with the measured angular distribution of the ground-state radiation are consistent with a 2^+ assignment to this level. (auth)

7097 ENERGY LEVELS OF Na^{21} AND Mg^{22}. F. Ajzenberg-Selove (Haverford Coll., Penna.), L. Cranberg, and F. S. Dietrich. Phys. Rev., 124: 1548-57 (Dec. 1, 1961).

Neon gas was bombarded with 2.4, 3.1, 4.6, and 6.1-Mev deuterons and with 3.4- and 4.5-Mev He^3 particles. Time-of-flight measurements of neutron groups indicate excited states of Na^{21} at 0.37 ± 0.04, 1.69 ± 0.05, 2.83 ± 0.04, 3.89 ± 0.05, 4.86 ± 0.06, and 5.01 ± 0.05 Mev, in addition to the well-known states at 2.43, 3.57, 4.18, 4.31, and 4.49 Mev. Angular distributions show strong direct interaction features. Mg^{22}, has a mass excess (M−A) of −0.14 ± 0.08 Mev (C^{12} reference) from Q = −0.043 ± 0.08 Mev for $Ne^{20}(He^3,n)Mg^{22}$. The first excited state is at 0.995 ± 0.04 Mev. No other states are observed with $E_x < 2.5$ Mev. (auth)

7098 EXCITATION FUNCTIONS OF K^{41} + p REACTIONS. R. D. Sharp, L. F. Chase, Jr., R. M. Friedman, E. K. Warburton, and E. G. Shelley (Lockheed Missiles and Space Co., Sunnyvale, Calif.). Phys. Rev., 124: 1557-67 (Dec. 1, 1961).

The energy of some of the gamma radiation following the proton bombardment of K^{41} was measured, and the origins of some of these gamma rays were determined. The excitation functions of the 1.00-Mev gamma from inelastic scattering in K^{41} and the 2.16-Mev gamma from the $K^{41}(p,\alpha\gamma)$ reaction were measured in a region between 2.3 and 3.5 Mev and approximately 50 resonances observed. The energies and absolute cross sections, and the anisotropy of the gamma radiation proceeding from some of these resonances were measured, leading to information on the excited states in Ca^{42} at about 13-Mev excitation, including an upper limit on the average level spacing. Evidence is given to show the 100-Mev level in K^{41} is most likely a $\frac{1}{2}^+$ state in agreement with theoretical predictions. (auth)

7099 OBSERVATIONS ON NEUTRAL π MESONS PRODUCED IN NUCLEAR INTERACTIONS OF 24-Gev PROTONS WITH CARBON NUCLEI. Yash Pal and T. N. Rengarajan (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 124: 1575-6 (Dec. 1, 1961).

Energy-angle characteristics of neutron π mesons produced in interactions of 24-Bev protons with carbon nuclei were studied by detecting the γ rays from π^0 decay in a small emulsion stack. The energy of the γ rays was obtained from the opening angles of electron-positron pairs, using a special measuring criterion which was justified by making multiple scattering measurements on a fraction of the pairs. The average energy of neutron π mesons in the c.m. system was found to be 470 ± 35 Mev. The most probable value of their transverse momentum is 230 Mev/c and the average value is 398 ± 25 Mev/c. It is concluded that at 24 Bev the fraction of the available energy in the c.m. system spent in pion production is 0.43 ± 0.07. (auth)

7100 NUCLEAR SURFACE EFFECTS IN MUON CAPTURE. Paul Singer (Technion-Israel Inst. of Tech., Haifa, Israel). Phys. Rev., 124: 1602-9 (Dec. 1, 1961).

Slow-muon capture in heavy nuclei results in a moderately excited nucleus which emits mostly neutrons and to a lesser extent, charged particles. The neutron and alpha emissions can be explained as statistical emission from the compound nucleus formed. The experimentally observed proton emission is ten times higher than that predicted by the same mechanism. It is proposed to take into account clustering of nucleons at the nuclear surface in order to account for the increased proton emission. The capture of the muon by two-nucleon clusters at the surface of AgBr nuclei is calculated and the subsequent direct proton emission evaluated. The experimental findings can be explained with a reasonable strength of correlations assumed. (auth)

7101 PHOTODISSOCIATION OF COMPLEX NUCLEI AT ENERGIES BETWEEN THE MESONIC THRESHOLD AND 1150 Mev. Charles E. Roos (Vanderbilt Univ., Nashville) and Vincent Z. Peterson. Phys. Rev., 124: 1610-22 (Dec. 1, 1961).

The photodisintegration of complex nuclei by gamma rays up to 1150 Mev was studied by exposing nuclear emulsion to Bremsstrahlung from the Cal Tech electron synchrotron and observing the "photostars" produced. Exposures were made at 16 different peak energies between 250 and 1150 Mev. Nearly 10,000 photostars were analyzed for star frequency, prong number, angular distribution, and (at 1143 Mev) the visible energy release per star. The Bremsstrahlung yield of multiprong (≥2 prong) stars increases abruptly as photons capable of producing pions are included. The cross section per photon, derived from the Bremsstrahlung yield by the photon difference method, is essentially constant at 250 microbarns/nucleon at all energies above 300 Mev. A model for photostar production is given which involves photo-pion production followed by absorption or scattering of the pion and recoil nucleon. Experimental free-nucleon photo-pion cross sections are used, together with the Monte Carlo calculations of Metropolis et al., to determine the probability for star formation. Good agreement with both the shape and magnitude of the excitation curve is obtained if nuclear motion is included. Mean and maximum prong numbers for photostars are the same as for stars produced by pions or protons of equal available energy. The mean-free-paths in nuclear matter of pions and protons are short, so that photostar yields are a measure of the integrated total photomeson cross section. More than 95% of the multiprong stars made by 1-Bev Bremsstrahlung are made by photons whose energies exceed the pion production threshold of 150 Mev. Most of the 1-prong events are produced by photons below 150 Mev, and the yield is consistent with giant resonance (γ,p) reactions plus "pseudodeuteron" photodisintegration, a process whose cross section rapidly decreases as the photon energy increases. Variation of mean prong number with energy and comparison with nuclear cascade calculations suggests that the excitation of the residual nucleus is nearly constant at 100 Mev over a wide range of incident photon energies. The visible energy release per photostar shows a linear dependence on prong number, and more than half of the photon energy is carried away by neutron particles. (auth)

7102 NEUTRON COHERENT SCATTERING AMPLITUDES FOR Cd AND Eu. George Arnold and Norris Nereson (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 124: 1848-51 (Dec. 15, 1961).

The neutron coherent scattering amplitudes of Cd and Eu were measured from diffraction studies on CdO and Eu_2O_3 at a neutron wavelength of 1.391 A. Using the value of 0.58×10^{-12} cm as the scattering amplitude for oxygen, the experimental values for the Cd and Eu coherent scattering lengths are $|f_{Cd}| = (0.58 \pm 0.03) \times 10^{-12}$ and $|f_{Eu}| = (0.55 \pm 0.04) \times 10^{-12}$ cm. The experimental values for the nonresonant coherent scattering lengths are $f_0(Cd) = (0.78 \pm 0.04) \times 10^{-12}$ cm and $f_0(Eu) = (0.80 \pm 0.05) \times 10^{-12}$ cm. The phase of the scattering for both elements is positive. (auth)

7103 REACTIONS OF ALPHA PARTICLES WITH TIN-124. R. L. Hahn and J. M. Miller (Columbia Univ., New York and Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 124: 1879-87 (Dec. 15, 1961). (BNL-5597)

The excitation functions for the (α,n), (α,p), (α,pn), $(\alpha,2pn)$, $(\alpha,3n)$, and $(\alpha,\alpha n)$ reactions of Sn^{124} were determined with alpha particles from 13-42 Mev of excitation energy. Cross sections for the production of the isomers of Te^{127}, Sb^{126}, Sn^{125}, and Sn^{123} are also presented. Reactions in which there is only neutron emission predominate: the maximum cross sections for (α,n) and $(\alpha,3n)$ (metastable state) are 0.161 barn at 18 Mev of excitation and 1.18 barn at 36 Mev, respectively. The (α,p) has its maximum of 0.017 barn at 28 Mev, while the largest cross section obtained for the $(\alpha,\alpha n)$ reaction is 0.056 barn at 42 Mev. The results are discussed in terms of the statistical theory of nuclear reactions. A satisfactory fit to the (α,n) and (α,p) data is obtained for $r_0 = 1.7$ fermis and $a = 1.6$ Mev^{-1}. However, both excitation functions exhibit high energy tails not predicted by the theory. An evaporation calculation using $a = 1.6$ Mev^{-1} yields cross sections of proper magnitude for the $(\alpha,\alpha n)$ reaction; but the shape of the experimental curve is not indicative of compound nuclear processes. (auth)

7104 NUCLEAR COMPRESSIBILITY AND SYMMETRY ENERGY. David S. Falk (Universitâ, Genoa) and Lawrence Wilets. Phys. Rev., 124: 1887-96 (Dec. 15, 1961).

A modification and generalization of the Puff-Martin model for many-fermion systems is employed to calculate nuclear compressibility and symmetry energy in order to provide a practical test of the model and at the same time obtain useful information about these interesting quantities. An alternative, heuristic, derivation of the Puff-Martin equations is presented in order to exhibit the role of the exclusion principle. The condition stated for normal nuclear matter is that the mean binding energy be minimal (with respect to variation of the Fermi momentum) rather than the Puff-Martin condition that the mean binding energy equal the "single particle" energy at the Fermi surface. These two quantities differ from each other by the rearrangement energy, which is found to be 10 Mev. Employing Puff's potential (hard-shell potential plus a separable Yamaguchi potential, acting only in relative S states), satisfactory agreement is obtained with observed binding energy and density. The value of nuclear compressibility, 214 Mev, falls within the wide range of semiempirical values. The symmetry energy coefficient, 43 Mev, is larger, by 40 to 80%, than those usually quoted in semiempirical mass formulas. However, the value of the symmetry coefficient is the same as that previously calculated by others in the absence of odd-state forces. (auth)

7105 NUCLEAR MAGNETIC MOMENT OF THE 158-KEV $5/2^-$ STATE OF Hg^{199}. L. Grodzins, R. W. Bauer, and H. H. Wilson (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 124: 1897-8 (Dec. 15, 1961).

The nuclear magnetic moment of the 158-kev, $5/2^-$ state was measured by precessing, in a solid gold environment, the $3/2^-$ (334 kev) $5/2^-$ (158 kev) $1/2^-$ gamma ray-gamma ray angular correlation in an external magnetic field of 26,000 gauss. The value obtained, $\mu_{5/2} = +1.03 \pm 0.08$ nm, includes a 5% correction for quadrupole attenuation as determined by studying the angular correlation as a function of the delay of the intermediate state. The value is compared to the recent prediction of de-Shalit assuming that the $5/2^-$ state originates from the coupling of the $1/2^-$ ground state ($\mu_p = +0.504$ nm) with the 2+ excitation of the core. The magnetic moment of the core excitation was obtained from the M1 gamma-ray mean life of the 50-kev transition between the $3/2^-$ (208 kev) and $5/2^-$ (158 kev) core-particle doublet. That mean life, determined to be $\tau_\gamma(50) = (4.46 \pm 1.0) \times 10^{-9}$ sec, leads to predicted magnetic moments of $\mu_{core} = (+0.33_{-0.25}{}^{+0.17})$ mn and $\mu_{5/2} = (+0.84_{-0.25}{}^{+0.17})$ nm. (auth)

7106 ANGULAR DISTRIBUTIONS OF 4.43-MEV GAMMA RADIATION FROM $C^{12}(p,p'\gamma)C^{12}$. H. S. Adams, J. D. Fox, N. P. Heydenburg, and G. M. Temmer (Florida State Univ., Tallahassee). Phys. Rev., 124: 1899-1903 (Dec. 15, 1961).

The yield at 90 degrees, and 32 angular distributions of the 4.43-Mev gamma ray from the first-excited state of C^{12} were measured for proton bombarding energies between 5 and 12 Mev. The excitation curve for inelastic scattering is characterized by a number of strong resonances, some of which were previously known. In addition, underlying the resonances, there is a monotonically rising background. The angular distributions were fitted by least squares to the expression $W(\theta) = A_0 + A_2P_2(\cos\theta) + A_4P_4(\cos\theta)$. Those obtained in the region of the resonances at $E_p = 5.36$ Mev and $E_p = 5.89$ Mev can be interpreted by taking into account these two resonances with respective characters $3/2^+$ and $5/2^+$ plus one additional state at an excitation energy of 6.38 Mev ($5/2^+$) in the compound nucleus N^{13} which can be seen only in elastic scattering. A simple direct-reaction model using a nucleon-nucleon interaction accounts very well for four angular distributions at higher energies in regions showing no resonant structure. (auth)

7107 HYPERFINE STRUCTURE AND NUCLEAR MOMENTS OF AMERICIUM-242. Richard Marrus and Joseph Winocur (Univ. of California, Berkeley). Phys. Rev., 124: 1904-6 (Dec. 15, 1961). (UCRL-9757)

The hyperfine structure of $_{95}Am^{242}$ ($T_{1/2} = 16$ hr) in the $J = 1$ electronic ground state was studied by the atomic-beam technique using radioactive detection. The nuclear spin is found to be $I = 1$. The measured values of the magnetic-dipole interaction constant A and the electric-quadrupole interaction constant B are $A = \pm 10.124(10)$ Mc/sec and $B = \pm 69.639(40)$ Mc/sec, respectively. Combining these measurements with optical spectroscopic and atomic-beam data for Am^{241}, the nuclear magnetic-dipole moment is inferred to be $\mu_I = \pm 0.33$ nm and the nuclear quadrupole moment $Q = \mp 2.76$ barns. These results are discussed in terms of the Bohr-Mottelson nuclear model. (auth)

7108 Eu^{149} DECAY. Otto K. Harling (Pennsylvania State Univ., University Park). Phys. Rev., 124: 1907-10 (Dec. 15, 1961).

The electron capture decay of Eu^{149} to Sm^{149} was studied using scintillation and proportional counters. A decay scheme is given which is consistent with the measured coincidence data. The half life of the Eu^{149} decay was measured to be 106 ± 2 days. (auth)

7109 DETERMINATION OF THE LIFETIME OF THE FIRST-EXCITED STATE OF Gd^{152}. J. Burde, M. Rakavy, and S. Ofer (Hebrew Univ., Jerusalem). Phys. Rev., 124: 1911-14 (Dec. 15, 1961)

The lifetime of the 344-kev level of Gd^{152} was measured by coincidence measurements between the beta spectrum of Eu^{152} and the K conversion line of the 344-kev transition, using a double lens coincidence spectrometer. The time delay between the outcoming coincident pulses was converted to pulse height. From the calibrated shift of the centroids, using the self-comparison method, a mean lifetime of $\tau = (7.6 \pm 1.3) \times 10^{-11}$ sec was obtained. The transition probability is 20 times the single-proton value. Thus, although the level is not rotational, it has considerable collective character. (auth)

7110 DECAY OF Cd^{113} AND In^{113} ISOMERS. Chester E. Gleit and Charles D. Coryell (Massachusetts Inst. of

Tech., Cambridge). Phys. Rev., 124: 1914-16 (Dec. 15, 1961).

The isomers 9.5-min Cd^{119} and 2.7-min Cd^{119m} are formed in the fission of natural uranium induced by 14-Mev deuterons and fast neutrons, with the latter reaction favoring the production of the low-spin 9.5-min isomer. The decay of 18-min In^{119m}, the daughter of 9.5-min Cd^{119}, is characterized by β rays with a maximum energy of 2.7 Mev and γ rays of 0.024, 0.30, and 0.91 Mev. Some (~5%) isomeric transition is observed. The decay of 2.0-min In^{119} is characterized by 1.6-Mev β rays and 0.82-Mev γ rays. (auth)

7111 LEVEL STRUCTURE OF Ar^{41} FROM THE $Ar^{40}(d,p)Ar^{41}$ REACTION. E. Kashy, A. M. Hoogenboom, and W. W. Buechner (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 124: 1917-22 (Dec. 15, 1961).

The energy-level structure of Ar^{41} was investigated by bombarding argon gas with 7.5-Mev deuterons and measuring the energy spectrum and angular distributions of the reaction protons. A Q value of 3.874 ± 0.006 Mev was measured. Fifty levels were observed, and their excitation energies, l_n values, reduced widths, and shell-model configurations were determined. Mean energies of the shell-model configurations were: $1f_{\frac{7}{2}}$, 0 Mev; $2p_{\frac{3}{2}}$, 1.50 Mev; $2p_{\frac{1}{2}}$, 3.53 Mev; $3s_{\frac{1}{2}}$, 4.78 Mev; $2d_{\frac{5}{2}}$, 4.86 Mev; and $1f_{\frac{5}{2}}$, 5.55 Mev. (auth)

7112 SPECTRA OF (p,α) AND (p,p′) REACTIONS AND THE EVAPORATION MODEL. R. Sherr and F. P. Brady (Princeton Univ., N. J.). Phys. Rev., 124: 1928-43 (Dec. 15, 1961).

The energy spectra of α particles from V, Fe, Co, Ni, and Rb bombarded with 17.5-Mev protons were obtained at a number of angles. Beyond 30°, the spectra are essentially isotropic and were analyzed in terms of the evaporation model. The level density deduced is of the form $\exp(E_x/T)$ for E_x = 3 to 12 Mev. The values of T are in the range 1.2 to 1.5 Mev if the cross sections of the continuum model with $R = (1.4A^{1/3} + 2.2)$ fermis are used, and in the range 1.3 to 1.6 Mev if optical model cross sections are used. This "constant temperature" level density is also consistent with alpha spectra of Ni and Co bombarded 15- and 19-Mev protons. Analysis of published inelastic proton scattering data for elements in the Ti-Zn region, with bombarding energies of 11.3 to 23 Mev, indicates that the (p,p′) spectra (in the above excitation interval) are only partially attributable to evaporation. At 11.3 Mev the upper limit of the contribution of evaporation to the proton spectra is estimated to be ≤96%, while at 23 Mev it is probably much smaller than 22%. The value of T for Fe^{56} deduced from (p,α) and (α,α′) reactions is ~1.5 Mev, while inelastic neutron scattering data yield a value of 0.95 Mev. The resolution of this disagreement will require modification of the usual calculations of inverse cross sections. (auth)

7113 STUDY OF THE PROPERTIES OF THE 4.97-MEV LEVEL IN Ne^{20} USING THE $F^{19}(p,\gamma)Ne^{20}$ REACTION. H. E. Gove, A. E. Litherland, and A. J. Ferguson (Atomic Energy of Canada, Ltd., Chalk River, Ont.). Phys. Rev., 124: 1944-7 (Dec. 15, 1961).

The reaction $F^{19}(p,\gamma)Ne^{20}$ was studied at two resonances, 669 kev and 1092 kev, to obtain information about properties of the 4.97-Mev level in Ne^{20}. It is shown that this 4.97-Mev level is fed by a direct transition from the 1+ resonance at 669 kev, that it does not have spin 0 and that its transition to the ground state of Ne^{20} is less than 5% of the transition to the first excited state. It is concluded that the most likely assignments to the 4.97-Mev level are 2± or 3+. (auth)

7114 YIELDS OF KRYPTON ISOTOPES FROM THE DEUTERON AND ALPHA BOMBARDMENT OF HEAVY NUCLEI. Morton Kaplan and Charles D. Coryell (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 124: 1949-58 (Dec. 15, 1961).

The relative yields of 4.4-hr Kr^{85m}, 78-min Kr^{87}, and 2.8-hr Kr^{88} were measured radiochemically for the fission of Th^{232}, U^{235}, and U^{238} induced by 14- and 9-Mev deuterons and 25-Mev alpha particles. Yields of these nuclides were also determined for the fission of U^{235} with thermal neutrons. By correcting for charge distribution, relative chain yields were obtained for mass numbers 85, 87, and 88. The results for thermal neutron fission of U^{235} are in good agreement with mass-spectrometrically determined yields at these mass numbers. Deviations from smooth yield-mass curves are found for deuteron fission of Th^{232} and alpha-particle fission of Th^{232}, U^{235}, whereas deuteron fission of U^{235} and U^{238} show normal mass yields. The origin of these fine-structure effects is not understood, but no evidence was found for a systematic influence of the 50-neutron shell in perturbing the fission yields in the krypton mass region. (auth)

7115 DEUTERON POLARIZATION IN THE $Be^9(p,d)Be^8$ REACTION. James M. Lambert, Leon Madansky, and George E. Owen (Johns Hopkins Univ., Baltimore). Phys. Rev., 124: 1959-63 (Dec. 15, 1961).

The polarization of the deuterons from the $Be^9(p,d)Be^8$ reaction was investigated at two angles, 30° and 90°, at an incident proton energy of 3 Mev. The deuteron polarization was measured by utilizing the asymmetry of the protons from the $D(d,p)H^3$ reaction. The asymmetries were corrected for the finite geometry of the experiment. The analysis of the polarization from this data was performed employing a restricted set of interactions, and the deuteron polarization was found to be +(11 ± 5)% at 30°, and + (6 + 3)% at 90°. The sign of the polarization is in agreement with the semiclassical model, and the magnitude is less than the theoretical upper limit of 33%. (auth)

7116 REACTION CROSS SECTIONS OF U^{233} AND U^{238} WITH 18-43 MEV HELIUM IONS. J. R. Huizenga, R. Vandenbosch, and H. Warhanek (Argonne National Lab., Ill.). Phys. Rev., 124: 1964-70 (Dec. 15, 1961).

The fission cross sections were measured for U^{233} and U^{238} targets bombarded with 18 to 43 Mev helium ions. These targets were chosen because of their large fission cross sections. In addition, the spallation cross sections are known and represent with 43-Mev helium ions only about 4 and 9% of the reaction cross sections of U^{233} and U^{238}, respectively. The fission fragments were detected with solid-state counters in a small evacuated scattering chamber. The fission fragment counting rates were converted to disintegration rates with previous measurements of the fission fragment angular distributions. The experimental reaction cross sections are in good agreement with reaction cross sections calculated with an optical model in which the complex nuclear potential derived by Igo for alpha-particle elastic scattering is employed. The dependence of the optical model cross sections on the various Woods-Saxon parameters is discussed. (auth)

7117 SCATTERING OF μ MESONS FROM THE NUCLEI OF BROMINE AND SILVER. George H. Rawitscher (Yale Univ., New Haven). Phys. Rev., 124: 1978-81 (Dec. 15, 1961).

The μ-meson elastic scattering cross section and polarization asymmetry factor are calculated for bromine for positive and negative muons, and for silver for negative muons, for the values of v/c = 0.4, 0.6, and 0.7. These

results, when combined with the ones available for cadmium, permit the comparison of theory with measurement of the scattering of muons in emulsions. The nuclei are taken to be extended, with a charge distribution as derived from electron scattering, the Dirac equation is assumed valid, and the calculation is done with the aid of an IBM-650 computer utilizing the same program as used previously for the calculations on cadmium and mercury. (auth)

7118 EXPERIMENTAL OBSERVATION OF A NEW REGION OF NUCLEAR DEFORMATION. Raymond K. Sheline, Torbjoern Sikkeland, and Richard N. Chanda (Univ. of California, Berkeley). Phys. Rev. Letters, 7: 446-9 (Dec. 15, 1961). (UCRL-9888)

Experimental evidence for nuclear deformation in the 50- to 82-proton region is presented for the cases in which $N \cong Z$. In order to study the energy levels of these nuclei, new La and Pr nuclides were discovered, and those having a relatively certain half-life and first excited state are reported. Odd-odd nuclei whose decay into daughter even-even nuclei giving a rotational band built on the ground state with spins 0+, 2+, 4+, ..., and ratios of energies to the first excited state 1.0 : 3.33 : 7.00 ..., were used to prove that nuclei are deformed. (L.N.N.)

7119 INTRODUCTION OF BERYLLIUM GRANULES INTO PHOTOEMULSION. V. P. Perelygin, S. A. Myachkova, and K. D. Tolstov (Inst. of Physics, Academy of Sciences, USSR). Pribory i Tekh. Ekspt., 6: No. 4, 145-7 (July-Aug. 1961). (In Russian)

Reactions of 14-Mev neutrons with Be^9 in an emulsion loaded with spherical beryllium granules are studied, and the α-particle tracks emitting from the granules are analyzed. (R.V.J.)

7120 ELASTIC SCATTERING OF 6.8 Mev PROTONS ON Cr, Co, Ni, Cu, and Zn NUCLEI. Tich-ling Chou, Chêng-ling Mao, Jung-fang Yüan, and Chung-yao Chao (Academy of Sciences, China). Sci. Sinica (Peking), 10: 806-11(Nov. 1961). (In Russian)

Elastic scattering of 6.8-Mev protons on even-Z Ni, Cr, and Zn and odd-Z Co and Cu was investigated. An abnormal phenomenon was observed with Ni. Proton scattering is almost identical at 5.25 and 7.5 Mev, but the ratio of the differential scattering cross section to the differential Coulomb scattering cross section $\sigma_e(\theta)/\sigma_R(\theta)$ differs considerably at large angles. The magnitude $\sigma_e(\theta)/\sigma_R(\theta)$ for nuclei with even Z is larger than for nuclei with odd Z. (R.V.J.)

7121 A METHOD OF FINDING OUT THE DISTRIBUTION FUNCTION OF THE ENERGY LEVELS OF A SPIN SYSTEM OF NORMAL PARAMAGNETICS. A. S. Kuznetsov. Uchenye Zapiski Tadzhik. Gosudarst. Univ., 18: 70-2(1958).

It is shown that the distribution of the spectrum points of the spin-spin-interaction operator can be considered as the Gaussian distribution with its center at zero and with very small dispersion; the method is analogous to the method of qualitative investigation of the energy spectrum nature of the atomic nucleus. (Refrat. Zhur. Fiz., No. 6, 1960). (OTS)

7122 THE PROBLEM OF THE HYPERFINE INTERACTION OF THE S-ELECTRON WITH THE MAGNETIC MOMENT OF THE DISPLACED NUCLEUS. L. A. Shul'man. Uchenye Zapiski Tadzhik, Gosudarst. Univ., 18: 73-78 (1958).

The spectrum of the hyperfine nucleus structure was calculated (spin $\frac{1}{2}$, 1, or $\frac{3}{2}$), for a nucleus displaced by a certain distance relative to the symmetry center of the S-electron wave function. The problem is solved first for the case when the statistical magnetic field H = 0, and the interaction of the nucleus with the electron is considered as a small perturbation. It is shown that the energy corrections, calculated to a relativistic approximation and to the Pauli approximation, coincide. Moreover, the case H = 0 is considered in the Pauli approximation. Therefore, it is assumed that: the splitting in the normal Zeeman effect is considerably less than the splitting caused by the spin-orbit interaction; and the normal Zeeman effect is considerably greater than the distance between the levels of the hyperfine structure. The case is also considered, when the second restriction does not take place. (Referat. Zhur. Fiz., No. 6, 1960).

7123 EXCAPE OF RECOIL NUCLEI IN x,ν REACTIONS. J. Biersack and K. E. Ziman (Hahn-Meitner-Institut für Kernforschung, Berlin). Z. Naturforsch., 16a: 849-53(Sept. 1961). (In German)

From the well-known escape probability of a recoil nucleus with a given energy and direction from the surface layer of a solid body, the escape probability was derived for the case in which a spectrum of recoil directions is present, for example in (n,p) reactions with reactor neutrons. The general derivations were applied to the special cases Al(n,p)Mg and Al(n,α)Na. (tr-auth)

7124 PRECISION MEASUREMENT OF THE LOW ENERGY NEUTRON CAPTURE GAMMA RADIATION IN Gd^{156}, Gd^{158}, Sm^{150}, Sm^{153}, AND Eu^{152}. Otto W. B. Schult (Technische Hochschule, Munich). Z. Naturforsch., 16a: 927-32(Sept. 1961). (In German)

Accurate energy values of the low energy gamma radiation, which Gd^{156}, Gd^{158}, Sm^{150}, Sm^{153}, and Eu^{152} emitted shortly after their excitation by neutron capture, were given. The measured values were compared with the energy values to be expected from the predictions of the collective model. (tr-auth)

7125 THE METHODS FOR THE DETERMINATION OF THE ENERGY DEPENDENCE OF THE CROSS SECTION OF THE REACTION $O^{16}(t,n)F^{18}$. Knut Lorenzen and Dieter Koenig (Technische Hochschule, Munich). Z. Naturforsch., 16a: 933-6(Sept. 1961). (In German)

The cross section of the reaction $O^{16}(t,n)F^{18}$, which is used for the activation determination of oxygen, was determined in dependence on triton energy by a direction method. The values obtained could be compared with the effective cross sections measured by Jarmie with a triton accelerator. The pattern of the energy dependence was similar to that given by Jarmie. The absolute magnitudes of the effective cross section lies, however, at somewhat higher values. (tr-auth)

7126 THE ENERGY DISTRIBUTION OF TRITIUM β-SOURCES FROM Zr AND Ti CARRIERS. M. Knoll and M. Hartl (Technische Hochschule, Munich). Z. Naturforsch., 16a: 952-4(Sept. 1961). (In German)

H^3 β sources are often prepared by absorption on Zr or Ti carriers. As relatively thick active layers usually result, in which the H^3 molecule is introduced within the volume of the absorber, the spectral energy distribution of the H^3 gas is sharply modified. The energy spectra of two such "absorption sources," one with titanium carrier and a rated activity of 50 mc and the other with zirconium vapor-deposited on copper as carrier and a rated activity of 1 c are shown. The measurement methods and results are given. A comparison of the curves shows that the "usable" activity of the first source is about 10 times and that of the second source 300 times under the given rated activity. 95% of the radiated electrons have velocities under 10 kv. The number of electrons with energy >100 v

is < 5% of the number at the maximum of 0.7 or 1.5 v. The relative radiated electron-energy-mass, with reference to the appropriate volt velocity, contains maxima at 3, 300, and especially 6000 v. (tr-auth)

7127 DETERMINATION OF THE COMPOUND NUCLEUS AND STRIPPING FRACTIONS OF THE (d,p) AND (d,n) REACTIONS ON Zr^{94} AND Zr^{96}. R. Bock (Max-Planck-Institut für Kernphysik, Heidelberg, Ger.). Z. Physik, 164: 546-57(1961). (In German)

An experiment was accomplished which gives information on the reaction mechanism of the ($Zr^{94,96}$ + d) reactions. Total cross sections and excitation functions up to 11.8 Mev were measured for the reactions Zr^{94}(d,p), Zr^{94}(d,n), Zr^{96}(d,p), Zr^{96}(d,n) and Zr^{96}(d,2n) by the activation method. The results are compared with cross sections calculated according to the statistical theory of nuclear reactions. It is shown that the (d,p) reactions proceed almost completely by the stripping-mechanism. The (d,n) and (d,2n) excitation functions on the other hand are in good agreement with the predictions of the statistical theory and one can conclude that the compound nucleus mechanism is the dominating process. (auth)

7128 COMPARATIVE MEASUREMENTS OF β-SPECTRA OF Au^{198} AND Zn^{69}. N. A. Burgov, A. V. Davydov, and G. R. Kartashov. Zhur. Eksptl'. i Teoret. Fiz., 41: 1337-9(Nov. 1961). (In Russian)

β spectra of Au^{198} and Zn^{69} were measured with an ironless thoroidal β spectrometer at identical conditions; the β spectrum of Zn^{69} is known to have Fermi form. A difference between the β spectra was observed at low energies (100 to 300 kev) that reached (6.5 ± 0.5)% on a Fermi plot at 100 kev, a lack of electrons being found in this region of the Au^{198} spectrum. Some time ago a deviation of Au^{198} β-electron longitudinal polarization from v/c was observed at the same β-electron energies. (auth)

7129 RESONANCE ABSORPTION OF 23.8 kev γ-QUANTA BY Sn^{119} NUCLEI IN CRYSTALS. N. N. Delyagin, V. S. Shpinel, and V. A. Bryukhanov (Moscow State Univ.). Zhur. Eksptl'. i Teoret. Fiz., 41: 1347-58(Nov. 1961). (In Russian)

Resonance absorption of 23.8 kev γ quanta by Sn^{119} nuclei in SnO_2, SnO, β-Sn, and $SnNb_3$ crystals was studied. Resonance absorption spectra are obtained for absorbers of various thickness at liquid nitrogen and room temperatures and for the β-Sn crystal at solid carbon dioxide temperature. The probabilities for γ absorption without recoil energy losses and the values of the isomer shift relative to the γ-transition energy in the SnO_2 crystal were determined for each crystal. Quadrupole splitting of the absorption lines equal to (12.5 ± 1.5) 10^{-3} ev and (11.0 ± 1.5) × 10^{-3} ev was found for the SnO and β-Sn crystals respectively. The quadrupole splitting in the β-Sn crystal depends on the temperature. (auth)

7130 PRODUCTION OF THE NUCLEI N^{17} BY BOMBARDMENT OF SOME ELEMENTS WITH HEAVY IONS. G. N. Flerov, V. V. Volkov, L. Pomorskii, and Ya. Tys (Joint Inst. for Nuclear Research, Dubna, USSR). Zhur. Eksptl'. i Teoret. Fiz., 41: 1365-9(Nov. 1961). (In Russian)

A method of investigating the transfer reaction by recording delayed neutron activity is proposed. Li, C, Al, and Cu targets were bombarded with N^{15}, O^{16}, and Ne^{22} ions and N^{17} nuclei were observed. Cross sections for N^{17} production with 95 Mev N^{15} ions were obtained. N^{17} yields from thick C, Al, and Cu targets bombarded with O^{16} and Ne^{22} were measured. (auth)

7131 PHOTOPROTONS FROM Pr^{141}. V. G. Shevchenko and B. A. Yur'ev (Moscow State Univ.). Zhur. Eksptl'. i Teoret. Fiz., 41: 1421-6(Nov. 1961). (In Russian)

Angular and energy distributions and yields of photoprotons from Pr^{141} are measured for peak Bremsstrahlung energies of 22.5 and 33.5 Mev. The results show that the maximum photoproton production cross section corresponds to γ energies above 22 Mev, and that γ absorption in this region is chiefly of a quadrupole nature. (auth)

7132 KINETICS OF DESTRUCTION OF SUPERFLUIDITY IN HELIUM. V. P. Peshkov and V. K. Tkachenko (Inst. of Problems in Physics, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 41: 1427-32(Nov. 1961). (In Russian)

The kinetics of superfluidity destruction is investigated for the case of heat transfer along a capillary tube of 1.4 mm diameter and 8 m length. At T = 1.34°K and velocities of the superfluid part exceeding the critical velocity by 1.04 to 1.6 times, turbulence fronts were found to move with constant velocity from the hot end to the cold one with velocities between 1 to 3.7 mm/sec and from the cold end to the hot one with velocities of 0.1 to 2.5 mm/sec. (auth)

7133 A $\beta\gamma$ CORRELATION INVESTIGATION OF Pr^{144} DECAY. V. M. Lobashov and V. A. Nazarenko (Leningrad Inst. of Physics and Tech.). Zhur. Eksptl'. i Teoret. Fiz., 41: 1433-7(Nov. 1961). (In Russian)

Correlation between the β-electron and circular polarization of the γ-quantum in the allowed Pr^{144} decay transition was investigated. From the magnitude of the correlation a value of 1– instead of the previously accepted value of 0– can be assigned to the ground state Pr^{144}. (auth)

7134 QUANTUM CHARACTERISTICS OF THE 6.847 Mev LEVEL OF P^{30} OBSERVED IN THE REACTION $Si^{29}(p,\gamma)P^{30}$. A. K. Val'ter, Yu. P. Antuf'ev, E. G. Kopanets, A. N. L'vov, and S. P. Tsytko (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zhur. Eksptl'. i Teoret. Fiz., 41: 1449-53(Nov. 1961). (In Russian)

Resonance at 1330 kev in the reaction $Si^{29}(p,\gamma)P^{30}$ was investigated. Magnetically separated Si^{29} was used as a target, and a γ spectrometer with a NaI(Tl) crystal of 70 mm diameter and 50 mm height was used for the measurements. The quantum characteristics $J^{\pi} = 2^+$ and T = 1 were obtained for the P^{30} 6.847 Mev resonance level on the basis of measurements of the γ spectra and angular distributions. A scheme of γ transitions from the given resonance level is proposed. (auth)

7135 FINE STRUCTURE OF THE Pa^{231} α-RADIATION AND THE ENERGY LEVEL SCHEME OF THE Ac^{227} NUCLEUS. S. A. Baranov, V. M. Kulakov, P. S. Samoilov, A. G. Zelenkov, Yu. F. Rodionov, and S. V. Pirozhkov. Zhur. Eksptl'. i Teoret. Fiz., 41: 1475-83(Nov. 1961). (In Russian)

Results of an investigation of Pa^{231} decay are presented. Measurements were performed with magnetic α and β spectrometers and a spectrometric arrangement for γ measurements. Twenty monoenergetic α lines were detected in the α spectrum. Ten of these lines were established for the first time. From an analysis of the electron and γ spectra it was possible to detect some new conversion lines and identify the multipolarity of the γ transitions in the Ac^{227} nucleus. On the basis of available data a more complete energy level scheme of the Ac^{227} nucleus is constructed. (auth)

7136 DECAY SCHEME FOR Br^{75}. K. A. Baskova, S. S. Vasilev, No Seng Ch'ang, and L. Ya. Shavtvalov (Moscow State Univ.). Zhur. Eksptl'. i Teoret. Fiz., 41: 1484-6 (Nov. 1961). (In Russian)

The β^+ and γ spectra of Br^{75}, half-period 100 ± 5 min, are investigated. The β^+ spectrum consists of three components with end point energies at 1720, 1100, and 650 kev. Gamma transitions with energies of 285 and 620 kev are observed. A study of β^+-γ coincidences indicates the existence of a temporal correlation between the β^+ transition (1720 kev) and the γ transition (285 kev). A probable decay scheme of Br^{75} is suggested. (auth)

7137 HIGH ENERGY PHOTODISINTEGRATION OF Be^9 AND C^{12} NUCLEI. V. I. Mamasakhlisov and R. I. Dzhibuti (State Univ., Tbilisi, Georgian SSR). Zhur. Eksptl'. i Teoret. Fiz., 41: 1493-7(Nov. 1961). (In Russian)

Photo-absorption of Be^9 and C^{12} nuclei accompanied by the emission of protons is investigated on the basis of the α particle model of these nuclei. The results are compared with experimental results. (auth)

7138 THEORY OF NUCLEAR RESONANCE IN PARAMAGNETIC MEDIA. R. Kh. Timerov and K. A. Valiev (Inst. of Physics and Tech., Kazan Branch of the Academy of Sciences, USSR and Kazan Pedagogical Inst., USSR). Zhur. Eksptl'. i Teoret. Fiz., 41: 1566-75(Nov. 1961). (In Russian)

A general theory is presented of the shape and width of magnetic resonance lines in paramagnetic media. Interaction between the nuclear and electron spins in the system is due to dipole-dipole and contact forces. Precession, relaxation, and exchange motions in the electron spin system and thermal motion of the medium particles are taken into account. Formulas for the nuclear resonance line half-widths and shifts are derived for the limiting cases of fast and slow thermal motion in the medium. (auth)

7139 NONCOHERENT SCATTERING OF ELECTRONS ON NUCLEI AND THE MAGNETIC RADIUS OF THE NEUTRON. M. Ya. Kobiashvili (Tbilisi State Univ., Georgian SSR). Zhur. Eksptl'. i Teoret. Fiz., 41: 1628-31(Nov. 1961). (In Russian)

It is shown that the apparent smaller size of the neutron compared to that of the free proton as observed in the experiments of Hofstadter on the Be^9 nucleus can be partially explained by the binding of the neutron in the given nucleus. Thus the mean square radius of the neutron magnetic moment distribution appears to be larger if the neutron motion is taken into account. (auth)

7140 OPTICAL MODEL OF A NUCLEUS WITH A POLYNOMINAL POTENTIAL. A. V. Luk'yanov, Yu. V. Orlov, V. V. Turovtsev (Moscow State Univ.). Zhur. Eksptl'. i Teoret. Fiz., 41: 1634-43(Nov. 1961). (In Russian)

The shape of the potential in the optical nuclear model with surface absorption is investigated. For a polynomial potential parameters are chosen which yield a good description of the experimental data on 14-Mev neutron scattering. Various types of potentials are described. (auth)

7141 ON SCATTERING OF POLARIZED NEUTRONS IN FERROMAGNETIC AND ANTIFERROMAGNETIC SUBSTANCES. Yu. A. Izyumov and S. V. Maleev (Leningrad Inst. of Physics and Tech.). Zhur. Eksptl'. i Teoret. Fiz., 41: 1644-8(Nov. 1961). (In Russian)

The change in polarization during polarized neutron scattering in ferromagnetic and antiferromagnetic substances is considered. It is shown how the magnetic scattering cross section can be obtained by measuring the scattering cross section in a given direction and the polarization of the scattered neutrons. (auth)

7142 MATRIX ELEMENTS FOR β-TRANSITIONS. B. N. Zakhar'ev, N. I. Pyatov, and V. I. Furman (Joint Inst. for Nuclear Research, Dubna, USSR). Zhur. Eksptl'. i Teoret. Fiz., 41: 1669-72(Nov. 1961). (In Russian)

Nuclear matrix elements for allowed β transitions of a number of strongly-deformed nuclei are calculated. The matrix elements were computed according to the independent particle model and residual interactions between the nucleons were then taken into account. The reduced β-decay probabilities, ft, in the independent particle model differ from the experimental values by two or more orders of magnitude. Better agreement between the theoretical values of ft and those observed experimentally can be obtained by taking into account pair correlations. (auth)

7143 ON THE THEORY OF HEAVY NUCLEI-NUCLEON COLLISIONS. A. A. Emel'yanov (Lebedev Inst. of Physics, Moscow). Zhur. Eksptl'. i Teoret. Fiz., 41: 1673-4(Nov. 1961). (In Russian)

Collisions between heavy nuclei and nucleons are considered within the framework of hydrodynamic theory. It is demonstrated that the reference system in which the secondary particle distribution possesses forward-backward symmetry is not the c-system. (auth)

7144 RADIOAKTIVNYI IZOTOP SERY(S^{35}). (Radioactive Isotope S^{35}). V. A. Sokolov, E. A. Tikhomirova, and N. A. Kosolapova. Moscow, Atomizdat, 1960. 27p.

Descriptions are given of the physical properties and preparation of S^{35}. The applications of S^{35} and safety measures for operations with S^{35} are discussed. (R.V.J.)

7145 INELASTIC SCATTERING OF NEUTRONS IN SOLIDS AND LIQUIDS. Proceedings of the Symposium on Inelastic Scattering of Neutrons in Solids and Liquids, Held in Vienna, 11-14 October 1960. Proceedings Series. (International Atomic Energy Agency, Vienna). 1961. 662p. (STI/PUB/35). $12.00(IAEA).

Fifty papers presented at the Symposium on Inelastic Scattering of Neutrons in Solids and Liquids are given. Five of the papers are in Russian and three in French. Separate abstracts were prepared for 33 papers. The remaining 17 were previously abstracted for NSA. (M.C.G.)

7146 THE THEORY OF THE THERMAL-NEUTRON SCATTERING LAW. P. A. Egelstaff (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.25-38 of "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (In English)

The theoretical background to the neutron scattering law is discussed. It is shown how the effects of the thermodynamic equilibrium of the scattering sample may be included through a special time variable (y-time). Methods by which the self and interference terms may be separated are presented, and a detailed discussion of the self term is given. New experimental methods of studying the properties of the self term are explained, which have the advantage of deducing the maximum amount of information about the double Fourier transformation of the scattering law without actually making the transformations. This results in much higher accuracy in the parameters obtained. In the discussion it is shown how to determine the velocity correlation function for the scattering system. (auth)

7147 SOME PROPERTIES OF THE SPACE-TIME CORRELATION FUNCTION. P. Schofield (Atomic Energy

Research Establishment, Harwell, Berks, Eng.). p.39-50 of "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (In English)

In Van Hove's formalism for the scattering of slow neutrons, the cross section is related to a space-time correlation function for the scatterer. This is a complex function of position and time. However, by a transformation of the time variable, a real function is obtained. If the scatterer is treated classically, the classical correlation function should be related to this real function. The condition of detailed balance is then satisfied automatically. The short time behavior of the correlation function was examined, and conditions under which Vineyard's Gaussian approximation is valid are discussed. In this, the correlation function for a single atom depends only on the mean square displacement of the atom as a function of time. The second derivative of this "width function" is proportional to the correlation function for the velocity of the atom. It is suggested that liquid effects can be accounted for by a damping of the velocity correlation with time. Such a procedure gives a generalized Einstein relation, relating the diffusion constant and the lifetime of the velocity correlation. As an example, a "damped phonon" model is considered, and the variation of the width function with phonon lifetime discussed. (auth)

7148 LINE WIDTHS IN NEUTRON-PHONON AND NEUTRON-MAGNON SCATTERING. R. J. Elliott and H. Stern (Clarendon Lab., Oxford). p.61-74 of "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (In English)

Monochromatic neutrons are scattered by a single crystal in processes which create or destroy a single phonon so that the scattered neutrons have discrete energies which vary with the scattering angle. Because the phonons have a finite lifetime and a finite free path these discrete lines are broadened. Measurement of these widths provides important information about the interactions between phonons in a solid and, with the improved resolution now available, the first such data are appearing. The various interaction mechanisms were surveyed to provide order-of-magnitude estimates of the effects to be expected on theoretical grounds. The dominant effects are due to anharmonic forces, for which the width always increases with temperature T and phonon energy $\hbar\omega(q)$. The actual dependence varies considerably for different types of phonon and different temperature ranges. The effect of the Coulomb forces in polar crystals was also estimated. At room temperature the predicted lifetimes τ of the phonons are usually in the region of 10^{-11} to 10^{-12} sec, which is of the order observed. Interaction between phonons and conduction electrons in a metal can also be important, particularly at low T, since it predicts $\tau \sim 10^{-11}$ to 10^{-12} sec independent of temperature. The isotopic distribution and impurities, if present in fractions of a percent, give negligible effects. The lines observed for magnon scattering will also have a width. The major effect for magnons of large q is an interaction with phonons which varies with a high power of q. Anisotropy effects are important at small q. In metals there is an additional strong interaction between the localized magnetic electrons and the conduction electrons which in Fe gives $\tau \sim 10^{-11}$ to 10^{-12} sec for magnons of large q and probably is the dominant effect. Impurities in concentrations greater than 1% will give a broad line ($\tau < 10^{-12}$ sec), but magnon-magnon effects are negligible. (auth)

7149 NEUTRON THERMALIZATION AND THE PROPERTIES OF THE VAN HOVE PAIR CORRELATION FUNCTION. M. V. Kazarnovskii and A. V. Stepanov (Lebedev Inst. of Physics, Moscow). p.87-95 of "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (In Russian)

Previous authors, including F. L. Shapiro, developed a formalism with which it was possible to describe neutron thermalization by resolving the neutron distribution function according to energy groups. These energy groups correspond to a system of linear simultaneous equations; all the information about the law of exchange of energy between neutrons and moderating medium that is necessary for such a description was given by inserting the constants γ_{ik}. The most important of these, γ_{11}, is equivalent to the heat transfer coefficient introduced by von Dardel. Elsewhere, Van Hove showed that the problem of the interaction of neutrons with a system of bound atomic nuclei may be reduced to finding some four-variable function, G(r,t), characterizing the space time correlation of pairs of atomic nuclei. The relation between the real and imaginary parts of the function was derived; these correlations are similar to the results obtained by Schofield. The connection between this function and the coefficient γ_{11} is also described and very simple cases are discussed. (auth)

7150 THE EFFECT OF CRYSTAL ANHARMONICITIES ON NEUTRON SCATTERING. R. Scalettar (General Atomic Div., General Dynamics Corp., San Diego, Calif.). p.101-7 of "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (In English)

The problem of neutron scattering by a crystal was studied theoretically by means of the Feynman ordered operator calculus and the associated method of functional integration. For a crystal with special types of anharmonicities, the neutron scattering has, under certain circumstances, proved amenable to exact and nonperturbation theoretic calculation. Since the Feynman ordered operator calculus is a relatively new technique, a brief description of this method will first be given. It is shown that a formally satisfactory foundation for the calculus may be established by the use of power series expansions of functionals and the definition of ordered operators in terms thereof. A new derivation of Feynman's fundamental disentangling theorem is then presented. The relation of the calculus to the method of functional integration is discussed and a generalization of the disentangling theorem obtained. The above techniques were next applied to the problem of neutron scattering by a crystal, using the method of Fourier transformation of functional integrals. For the case of a cubic anharmonicity, an exact expression for the transition amplitude between arbitrary initial and final crystal states was obtained. Closed forms for the transition amplitude were also obtained for quartic and certain higher anharmonicities, which lead to the evaluation of Hardy-Airy integrals and for which the results are expressible in terms of Bessel functions of fractional order. A study of the Van Hove correlation function, including the effect of anharmonicities, was carried out by direct application of the ordered operator calculus. (auth)

7151 FOUR-ROTOR THERMAL NEUTRON ANALYSER. P. A. Egelstaff, S. J. Cocking, and T. K. Alexander (Atomic Energy of Canada Ltd., Chalk River, Ont.). p.165-77 of "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (In English)

The scattering of thermal neutrons can be studied in detail if the energy transfers which occur on scattering by

a sample can be measured accurately. To do this, it is necessary to use a double neutron spectrometer in which the energy of the incident and the scattered neutrons can be measured. A system of four choppers which operate in pre-determined phase relationships to one another and produce bursts of monochromatic neutrons is described. These bursts fall upon a sample and the energy of the scattered neutrons is measured by standard time-of-flight methods. A number of counters (not exceeding 30) can be arranged about the sample covering angles from 10° to 160°, and the data from these counters is recorded by modern tape recording techniques. This instrument was used for two years at the NRU Reactor at Chalk River, Canada, and the operating experience obtained over this period is given. The use of the instrument for both fundamental scattering measurements and reactor data purposes is described. (auth)

7152 A TWIN-ROTOR NEUTRON SPECTROMETER FOR SOLID-STATE RESEARCH. R. F. Dyer and G. G. E. Low (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.179-94 of "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (AERE-R-3494). (In English)

A spectrometer intended for studying the inelastic scattering of neutrons in solids and liquids was recently installed at Harwell. This instrument is used at the reactor PLUTO in conjunction with a horizontal hole tangential to the core having a thermal neutron flux at the center of approximately 4×10^{13} n/cm^2 sec. A suitable neutron beam is obtained by using a special "source-block" of light water and an adjustable collimator giving a beam divergence at the specimen variable between ¼° and 1° in both the horizontal and vertical planes. Fast neutrons and gamma-rays are removed from the beam with only fractional losses to the thermal-neutron flux by a stopper consisting of liquid-nitrogen-cooled single crystals of bismuth and beryllium which are respectively 12 in. and 3 in. long. The neutrons are monochromated by a pair of 10-in.-diameter slotted rotors which spin about vertical axes with a separation between centers adjustable from 14.5 to 24 in. The rotor speeds are variable between 12000 and 30000 rpm which corresponds to a minimum neutron wavelength of approximately 1.9 Å. With the rotors at present in use and for a spacing between rotor centers of 24 in., the wavelength resolution is 3.4%, and at a speed of 30000 rpm the neutron burst has a pulse width of 14 μsec. The scattered neutrons are detected by scintillation counters and their times of arrival recorded in terms of a binary-coded timing-channel number on magnetic tape for subsequent analysis. A continuous display of the scattered-neutron energy spectrum, giving a check on the progress of an experiment, is provided by a time-to-amplitude pulse converter and a 100-channel kicksorter. Details concerning the various components of the spectrometer are given, the method of control of the phasing of the rotors is described and the safety measures adopted are discussed. (auth)

7153 RESOLUTION OF VARIOUS DEVICES FOR NEUTRON SPECTROSCOPY. P. F. Zweifel and John M. Carpenter (Univ. of Michigan, Ann Arbor). p.199-217 of "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (In English)

The resolution function $\Delta E/E$ or $\Delta\lambda/\lambda$ or $\Delta\nu/\nu$ of mechanical monochrometers (dual phase-lagged rotating shutters) and of chopped crystal beams are compared, using the single crystal resolution function as a standard. Formulas are presented from which count rates and resolutions may be computed, and in terms of which optimization of a design may be accomplished. In addition, more accurate formulas are presented for count rates. Some representative numbers will be presented. A lower limit may be placed upon $\Delta E/E$ for the mechanical monochrometer from three different criteria: intensity, collimation, and permissible over-all dimensions (two flight paths). In a design it is necessary to consider these as independent variables and to determine which of the three limits the resolution. In addition the pile-up condition introduces further restrictions. The use of a crystal in place of either the first shutter or both will remove the condition for over-all dimensions partially or fully. Thus, when it is the limiting condition, it is advantageous to go to crystal systems, but when one of the others is the limiting condition the dual chopper may be superior. In particular, if there is a rotating shutter somewhere in the system, the problem of order contamination can be made less severe. (auth)

7154 COLD-NEUTRON SCATTERING EXPERIMENTS WITH LIQUID HELIUM. Harry Palevsky (Brookhaven National Lab., Upton, N. Y.). p.223-35 of "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (BNL-4921). (In English)

Cold-neutron scattering experiments clearly demonstrated the existence of localized excitation in He II of the nature first discussed by Landau and by Feynman. Experimental data from three different laboratories are generally in good agreement. These data give an average value for the "energy gap," $\Delta/K = 8.57 \pm 0.1$°K. The neutron data seem to be in agreement (within experimental error) with the thermodynamic data in the temperature region (< 1.7°K) where interactions between excitations are rare. This agreement leads one to conclude that the great majority (probably all) of the roton motions in He II possess a longitudinal polarization. (auth)

7155 NEUTRON SCATTERING BY "NORMAL" LIQUIDS. P. G. de Gennes (Commissariat à l'Énergie Atomique, Saclay, France). p.239-48 of "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (In English)

Neutron data on motions in normal liquids well below critical point are reviewed and classified according to the order of magnitude of momentum transfers $\hbar q$ and energy transfers $\hbar\omega$. For large momentum transfers a perfect gas model is valid. For smaller q and incoherent scattering, the major effects are related to the existence of two characteristic times: the period of oscillation of an atom in its cell, and the average lifetime of the atom in a definite cell. Various interpolation schemes covering both time scales are discussed. For coherent scattering and intermediate q, the energy spread is expected to show a minimum whenever q corresponds to a diffraction peak. For very small q the standard macroscopic description of density fluctuations is applicable. The limits of the various (q) and (ω) domains and the validity of various approximations are discussed by a method of moments. The possibility of observing discrete transitions due to internal degrees of freedom in polyatomic molecules, in spite of the "Doppler width" caused by translational motions, is also examined. (auth)

7156 SLOW NEUTRON SCATTERING BY NORMAL LIQUIDS ACCORDING TO THE SMEARED POTENTIAL MODEL. A. Morales-Amado (National Univ. of Mexico, Mexico City) and R. K. Osborn. p.251-6 of "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (In English)

A dynamical model for normal liquids, long employed for the correlation of thermodynamic data on such sub-

stances and originally proposed by Lennard-Jones et al., was used to calculate the non-interference part of the neutron scattering cross-section for a variety of normal liquids. This model implies that the energy of the liquid may be expressed as the sum of the energies of the non-interacting molecules that comprise it—each moving in a simple harmonic potential characterized by a force constant which is an explicit function of the parameters of the (L-J) two particle potentials, the mean inter-particle spacing in the liquid and the number of "nearest neighbors" surrounding a given molecule. Such a description implies that the interference scattering is purely elastic and that the inelastic scattering can be quite rigorously computed. The model corresponds in some sense to the conception of short range, ordered units within the liquid which are sufficiently massive so that the coherent scattering from these units is not measurably inelastic. Such a dynamical description of the liquid implies that it is the predictions as to the inelastic scattering from normal liquids that will be most clearly sensitive to the details of the model. Since angular distributions are dominated by the interference scattering and since the model has not yet been sufficiently refined to be explicit in this regard, only qualitative agreement with such experiments was obtainable. More relevantly, comparison was made with the experiment of Pelah et al., which provides some information about the temperature dependence of the broadening of an incident spectrum due to inelastic scattering. The calculated results were within the errors quoted for the experiment. (auth)

7157 SCATTERING OF NEUTRONS IN LIQUIDS. B. F. Turchin. p.259-64 of "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (In Russian)

A formula is presented for the scattering cross section of slow neutrons in a liquid in incoherent approximation. The formula, which is based on the analysis of the quantum correlation function introduced by Van Hove and derived in an analogous manner for crystals, is in good agreement with exact theory. (auth)

7158 SLOW-NEUTRON INELASTIC SCATTERING MEASUREMENTS AT THE MATERIALS TESTING REACTOR. R. M. Brugger and J. E. Evans (Phillips Petroleum Co., Idaho Falls, Idaho). p.277-90 of "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (In English)

The inelastic scattering program at the MTR is directed toward the following objectives: a survey of many possible moderating materials in order to detect unique properties, experimental measurements of the angular and energy distributions of neutrons scattered from the most used and the most promising moderating materials in order to provide improved differential cross-sections for reactor calculations, and experimental and theoretical studies of the basic properties of matter that produce these inelastic effects. Survey data of the cold neutrons scattered at 90° by samples of zirconium hydride, water, ethyl alcohol, amyl alcohol, benzene and paraffin were obtained by use of the spinning sample method. In this method, which was developed at the MTR, a rapidly moving sample is passed through a beam of Be-filtered neutrons. Bursts of scattered neutrons are produced and the energies of the neutrons are measured by time-of-flight analysis. The surveys are being extended with a cold neutron facility and slow chopper that were installed recently. To make more detailed measurements of energy dependent and angular dependent differential cross-sections, a phased chopper velocity selector with a 4096-channel time analyzer was placed in operation. Two Fermi-type choppers spaced 3.4 m apart and two rotating collimators spin at speeds up to 5225 rpm to produce neutron bursts as narrow as 35 μsec at a distance of 2.5 m from the last chopper. The phase instability of the two choppers contributes less than 10% to the burst width. Data at several angles and for all final energies are taken simultaneously for each initial energy. Measurements of the scattering from molecules of methane gas are being conducted to develop procedures, to test Egelstaff's scattering surface presentation, and to compare against theoretical results. A theory which considers the rotational and vibrational states specifically was developed. The velocity selector was used to measure portions of the dispersion curves for beryllium and to survey a liquid (methanol) and gases (steam and methane). An energy state of 0.0002 ev is indicated in methanol. (auth)

7159 SCATTERING OF THERMAL NEUTRONS BY POLARIZED MOLECULES. J. Janik, Sz. Kraśnicki, and A. Murasik (Centre of Nuclear Physics, Krakow). p.293-5 "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (In English)

Measurements of the transmission of slow neutrons in a sample of p-azoxyanisol in the so-called nematic state were performed. A distinct, reproducible change of transmission was obtained when a magnetic field which caused a polarization of sample was applied. The behavior of this change as a function of neutron energy was interpreted as connected with torsional oscillations of CH_3-groups of the molecules and with the free rotation of the whole molecule around its longitudinal axis. (auth)

7160 TOTAL NEUTRON SCATTERING CROSS-SECTIONS OF SOME HYDROGENOUS MOLECULES: EXPERIMENTS AND INTERPRETATION. J. A. Janik, J. Janik, F. Maniawski, H. Rzany, A. Szkatula, J. Sciesiński, and A. Wanic (Centre of Nuclear Physics, Krakow). p.297-303 of "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (In English)

Measurements and calculations were performed for C_2H_4 and NH_3 molecules, making an attempt at verification of the Krieger and Nelkin theory of neutron scattering by molecules. A good agreement was obtained. A comparison of measured cross sections for several liquids (NH_3, H_2S, H_2O) with those evaluated on the basis of this theory was made. From a systematic disagreement in the region of thermal neutron energies a strong interaction between molecules in the liquid state was inferred. Total neutron scattering cross section vs energy for CH_3SH molecules (in liquid and gaseous state) showed the existence of local maxima which could be interpreted as caused by inelastic transitions due to internal hindered rotation in the molecule. The reality of these maxima however cannot be considered well established. (auth)

7161 THE THERMAL NEUTRON SCATTERING LAW FOR LIGHT AND HEAVY WATER. P. A. Egelstaff (Atomic Energy Research Establishment, Harwell, Berks, Eng.). S. J. Cocking, R. Royston, and I. Thorson. p.309-30 of "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (In English)

A four-rotor thermal neutron analyzer was used to measure the scattering of neutrons of initially 0.03, 0.06 and 0.12 ev from light and heavy water. The water samples were run at room temperature and 150°C, and angles of scattering between 10° and 150° were covered. The data were analyzed in terms of the space/time correlation func-

tions of Van Hove and a new method is described for determining the mean square displacement of an atom in a liquid as a function of time. The behavior of the mean square displacement is discussed and the Gaussian approximation for the form of the self-diffusion function for atoms in liquid water was tested. These data are useful, in addition, for the description of neutron thermalization in reactors. How they are used for this purpose is also described. (auth)

7162 THE MEASUREMENT OF THE TOTAL CROSS-SECTION OF H_2O BETWEEN −150 AND +200°C WITH VERY SLOW NEUTRONS. Klaus Heinloth and Tasso Springer (Technische Hochschule, Munich). p.323-7 of "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (In English)

Neutrons in the energy range from 0.18×10^{-3} to 2.8×10^{-3} ev were obtained from a mechanical monochromator of moderate resolution. The total cross sections of ice, water, and water vapor were measured in this energy range as a function of energy and temperature. They increased smoothly with temperature but showed distinct discontinuities at the phase transitions, at which the cross sections for water were higher than the cross sections for ice and vapor. The cross sections can be explained at least qualitatively. The discontinuity at 0°C arises mainly from increased excitation of acoustical vibrations in water compared to ice, due to the lowering of binding forces. The difference between water and vapor comes mainly from a difference in the effective mass of the water molecule because rotations are hindered in water. (auth)

7163 COLD-NEUTRON SCATTERING EXPERIMENTS ON LIGHT AND HEAVY WATER. K. E. Larsson, S. Holmryd, and K. Otnes (Aktiebolaget Atomenergi, Stockholm). p.329-41 of "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (In English)

The molecular motions in light and heavy water were studied using the technique of inelastic scattering of cold neutrons. From the neutron spectra observed at different scattering angles, several conclusions are drawn regarding the structural dynamics of water. As regards light water, the intensity variation of the observed quasi-elastic scattering indicated that the cross-section is mainly determined by a Debye-Waller factor corresponding to a Debye temperature of about 130°K. A line-broadening was observed on the quasi-elastically scattered peak, which corresponds to a residence time of a molecule before it makes a diffusion jump, of about 2×10^{-12} sec. The inelastically scattered spectrum showed that transitions (energy gain) occur into an energy band from 0.1 ev down to zero. The intensity variation of the lower parts of the inelastic spectrum, expressed as a function of angle of observation, agreed relatively well with the variation predicted for a solid with a Debye temperature of that order, so there might well be a characteristic frequency spectrum in water. The results are compared with a gas model as well as with a solid model for scattering. The measurements on heavy water showed the same general tendency as regards the inelastic scattering. As the quasi-elastically scattered peak is built up of a mixture of coherently and incoherently scattered neutrons, the interpretation of this part of the neutron spectrum is considerably more complex for the case where D_2O is used as scatterer. A few results are given for the angular variation of the scattered neutron energy spectrom from D_2O. (auth)

7164 THE SCATTERING OF SLOW NEUTRONS BY LIGHT AND HEAVY WATER. K. Mikke (Inst. of Nuclear Research, Swierk k Otwocka, Poland and Atomic Energy Establishment, Trombay, India). p.351-6 of "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (In English)

The scattering of monochromatic slow neutron beams by thin liquid samples of light and heavy water was investigated. The average energy of scattered neutrons as a function of angle was studied for $\lambda = 1.322$ Å and $\lambda = 0.98$ Å incident neutrons. Some angular distributions of scattered neutrons were also measured. The monochromatic incident beam was obtained from a single-lead-crystal monochromator and the average energy of the singly scattered neutrons was determined by transmission through gold and silver foils. The experimental data were compared with calculated values for different models describing the microdynamics of liquids. The results seemed to indicate the presence of hindered rotations in heavy water and in the case of light water they give new data confirming the validity of Nelkin's model. (auth)

7165 QUASI-ELASTIC AND INELASTIC SCATTERING OF COLD NEUTRONS FROM WATER. H. H. Stiller (Gesellschaft für Förderung der Kernphysikalischen Forschung, Aachen) and H. R. Danner. p.363-73 of "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (In English)

In view of the disagreement between the results of recent measurements of quasi-elastic scattering it seemed worthwhile to reinvestigate the problem with as high a resolution as possible. For this purpose a different experimental technique was used. Instead of analyzing the energies of the scattered neutrons, the energy of the neutron beam incident on the sample was varied and those neutrons scattered in a particular direction passed through a Be filter before reaching the detector. The quantity measured was then proportional to an integral between zero and the filter cut-off energy over the energy distribution of the scattered neutrons. The same experiment method can also be used to measure the inelastic scattering. In this case, the various quantum levels due to hindered rotations and vibrations of the scattering molecules are observed in absorption, instead of in emission as with previously employed analyzing techniques. (auth)

7166 STUDY OF THE DIFFUSION AND THERMALIZATION OF NEUTRONS IN WATER AND ICE WITHIN A WIDE RANGE OF TEMPERATURES, USING THE IMPULSE METHOD. A. V. Antonov, B. V. Granatkin, Yu. A. Merkul'ev, and Ch. Smolik (Inst. of Physics, Academy of Sciences, USSR). p.377-94 of "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (In Russian)

The process of non-stationary diffusion of neutrons was studied in water within the temperature range 0.5 to 286°C and in ice at −196°C, and values were determined for the diffusion parameters. The diffusion co-efficient values obtained for water were approximated by the polynomial: $D(t)/D(21°C) = (0.934 \pm 0.028) + (0.289 \pm 0.009) \times 10^{-2}\, t + (0.106 \pm 0.003) \times 10^{-4}\, t^2$. It was found that when the water temperature is raised, anisotropy in the angular distribution of the scattered neutrons increases noticeably. It is shown that at the temperature of liquid nitrogen, the neutrons attain a state of thermal equilibrium with the ice in about 45 to 75 μsec. (auth)

7167 EXPERIMENTS ON THE THERMALIZATION OF SLOW NEUTRONS BY LIQUID HYDROGEN. D. Criber, B. Jacrot, A. Lacaze, and P. Roubeau (Centre d'Etudes Nucléaires, Saclay, France and Institut Fourier, Grenoble, France). p.411-17 of "Inelastic Scattering of Neutrons in

Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (In French, English, Russian, Spanish).

In order to increase the flux of neutrons of long wavelength ($\lambda > 4A$) emerging from a channel in the high flux reactor EL-3, A liquid hydrogen device was introduced into a channel of the reactor. The intensity gain for neutrons with a wavelength λ is a $G(\lambda)$ function which, for perfect thermalization and ignoring capture, is expressed by: $G(\lambda) = 225 \exp(-45.3/\lambda^2)$, assuming a temperature of 300°K for the neutrons before cooling and of 20°K after cooling. Heating resulting from radiation and gain obtained are discussed. (M.C.G.)

7168 NEUTRON MODERATION TO LOW TEMPERATURES. L. B. Borst (New York Univ., New York). p.437-44 of "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (In English)

Neutrons were moderated to 4°K in ice immersed in liquid helium. The Maxwell distribution showed an effective cross section for a $1/v$ absorber (indium) 8.5 times that of room temperature, almost precisely the inverse ratio of effective velocities. The moderation mechanism is thought to involve rotational transitions of the water molecule associated with a nuclear spin flip analogous to the ortho-para transition in molecular hydrogen. The estimated transition energy for a free gas molecule is 0.001 ev, 30% higher than an inelastic process observed by Hughes. While rotational transitions were not observed in condensed systems by conventional spectroscopic methods, they were detected in a dilute solution of water in a nonpolar solvent such as carbon tetrachloride. Quantitative measurements indicated that 70% of the neutrons are reaching thermal energies at 4°K. Since the capture probability is perhaps 1% per scattering, thermalization must occur in less than 25 scattering events. Inelastic scattering as a moderation process in water at normal temperatures would seem to involve transitions of 0.005 to 0.02 ev. These same transitions can be expected to moderate effectively to 50°K. Below this temperature the only reported transition would appear to be at 0.0005 ev attributed to the para-ortho transition. Moderation to temperatures below 1° requires energy levels of closer spacing. A homologous two proton molecule of larger moment of inertia is acetylene which should show ortho-para transitions capable of moderation to <1°K. (auth)

7169 THE PRODUCTION OF COLD NEUTRONS BY INELASTIC SCATTERING IN HYDROGEN-CONTAINING SUBSTANCES. D. O'Connor, E. Maliszewski, and W. Bedefek (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). p.447-51 of "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (In English, French, Russian, Spanish).

The proportion of cold neutrons in reactor thermal neutron spectra was increased by scattering in a cold moderator. Paraffin, lucite, and water were used at liquid nitrogen and room temperatures. Both lucite and paraffin were observed to be better cooling moderators than water probably because of inner atomic vibrations in their molecules. (M.C.G.)

7170 A SYSTEMATIC STUDY OF COLD-NEUTRON SOURCES. S. Hautecler and W. van Dingenen (Centre d'Étude de l'Énergie Nucléaire, Mol, Belg.). p.453-74 of "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (In French).

Measurements of the inelastic scattering of cold neutrons improve in direct relation to an increase in the intensity of the source. The number of cold neutrons emitted by a limited quantity of moderator, brought to a low temperature and situated in a thermal neutron stream depends on various parameters: temperature, dimensions, and nature of the moderating material. To obtain a better understanding of the influence of these different factors on the moderating power, measurements of effective temperature were taken out-of-pile with a cryostat which allowed the moderator dimensions to be changed. The substances investigated were graphite, beryllium, water, and the organic compounds acetone, benzene, paraffin, petroleum ether, butane, and methane. With the results of these measurements the most suitable values can be selected for the parameters governing a cold source. These preliminary measurements were followed by spectrum measurements on a cold-neutron source placed in the center of the BR 1 reactor. Using a crystal spectrometer, that part of the spectrum lying beyond the beryllium cut-off (wave-lengths greater than 4 Å) was measured for the moderators acetone, benzene, petroleum ether, methyl alcohol, and methane. The variation of the spectrum with moderator temperature was determined between the operating temperature of the reactor and the temperature of liquid nitrogen. (auth)

7171 EXPERIMENTAL DETERMINATION OF THE SPECTRUM FOR THERMAL OSCILLATIONS OF CRYSTALS OF ARBITRARY SYMMETRY BY MEANS OF INCH INCOHERENT SINGLE-PHONON SCATTERING OF COLD NEUTRONS. L. B. Tarasov (Order of Lenin Kurchatov Inst. of Atomic Energy, Academy of Sciences, Moscow). p.479-83 of "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (In Russian).

The relation between the cross section of incoherent single-phonon scattering of cold neutrons and the spectrum of oscillation frequencies in crystal was studied. It is shown that for a single crystal of arbitrary symmetry the frequency function is normally a linear combination of three scattering cross sections, measured, generally speaking, for three random arbitrary orientations of the sample, determined in relation to its main axes. It is also shown that for a polycrystal sample of arbitrary symmetry, isotropic throughout, the scattering cross section, correct to the Debye-Waller factor, is proportional to the frequency function. (auth)

7172 INELASTIC NEUTRON SCATTERING EXPERIMENTS ON A FEW METAL HYDRIDES. J. Bergsma (Institutt for Atomenergi, Kjeller, Norway) and J. A. Goedkoop. p.501-9 of "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (In English)

The dynamical behavior of the atoms in a number of metal hydrides is demonstrated by means of different neutron scattering techniques. In a single-crystal neutron diffraction investigation of electrolytically loaded palladium hydride, the decrease of the coherent scattering intensity due to the thermal motion of the atoms was observed. The root mean square displacements of the palladium and hydrogen atoms were found to be 0.10 ± 0.01 and 0.24 ± 0.02 Å, respectively. Measurements of the total neutron scattering cross section as a function of the neutron energy, and the energy spectrum of neutrons of average incident energy 0.004 ev after scattering at 90°, showed the exchange of energy between the neutrons and the lattice vibrations. Because of the high mass-ratio between the atoms, the results were interpreted in terms of an Einstein model for the optical vibrations. The excitation quanta ob-

served in this way are for palladium hydride 0.056 ± 0.002 ev, for aluminum thorium hydride ($AlTh_2H_n$) 0.079 ± 0.002 ev, and for calcium hydride 0.081 ± 0.003 ev. In the case of palladium hydride the root mean square displacement of the protons relative to the palladium sub-lattice calculated from this quantity is 0.22 ± 0.02 Å, in agreement with the coherent elastic scattering. Approximating the acoustical branch by a Debye model of vibration for the palladium hydride, a Debye temperature of 300 ± 25°K and a mean square displacement of 0.10 ± 0.01 Å were obtained. (auth)

7173 PHONON DISPERSION RELATIONS FOR A SILICON SINGLE CRYSTAL. G. Dolling (Cavendish Lab., Cambridge, Eng.). p.563-8 of "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (In English).

The energy distribution of neutrons scattered coherently from a silicon single crystal was studied, using a beam of 4.25 Å neutrons from the BEPO liquid hydrogen source. The incident beam was pulsed and monochromated by means of a curved slit rotor in conjunction with a nitrogen-cooled beryllium filter. The time of flight of scattered neutrons was recorded on a multichannel time analyzer. Peaks were observed in the scattered neutron energy distribution corresponding to one phonon process. The section of the scattering surface in the $(0\,\bar{1}\,1)$ plane was obtained for the TA and LA modes, from which one may determine the phonon dispersion relation in any direction in this plane. The relations in the [1 0 0] and [1 1 1] directions were compared with other experimental and theoretical results. (auth)

7174 THE PHONON FREQUENCY DISTRIBUTION IN GRAPHITE AT SEVERAL TEMPERATURES. P. A. Egelstaff (Atomic Energy Research Establishment, Harwell, Berks, Eng.) and S. J. Cocking. p.569-78 of "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (In English)

The scattering of thermal neutrons by graphite was studied with an elaborate neutron time-of-flight spectrometer installed at the NRU reactor. The results were analyzed by a new technique in order to yield the phonon frequency distribution for a coherent scattering material. Samples of graphite at temperatures ranging from 24° to 610°C were used. Frequency distributions were derived at each of the temperatures studied and were compared to the calculations of Baldock (1956). The effect of the anisotropy of the graphite lattice leading to a frequency distribution varying as $1/\nu$ for low ν is demonstrated and it is shown that the distribution for transverse waves is temperature dependent. (auth)

7175 THE PHONON FREQUENCY DISTRIBUTION IN VANADIUM AT SEVERAL TEMPERATURES. K. C. Turberfield and P. A. Egelstaff (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.581-5 of "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (In English)

A pulsed beam of 4 Å neutrons was scattered from a sample of vanadium into counters placed at 90°. The spectrum of scattered neutrons was determined by conventional time-of-flight methods for several temperatures of the vanadium. These data were analyzed in the way described by Placzek and Van Hove. Results showing the variation of frequency distribution with temperature are presented. (auth)

7176 MEASUREMENTS OF THE TEMPERATURE DEPENDENCE OF THE PHONONS IN ALUMINUM. K.-E. Larsson, S. Holmryd, and U. Dahlborg (Aktiebolaget Atomenergi, Stockholm). p.587-98 of "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (In English)

The cold neutron scattering technique was used to determine about 300 phonons in a single aluminum crystals at room temperature, thereby defining ten pairs of dispersion curves. Investigations were made of the variation of frequencies, phonon line widths, and multi-phonon spectra in the temperature range $293 \leq T \leq 932$°K. The dispersion curves for the high frequency branch show that the frequencies vary about 15% over this temperature range for a particular direction (310) in the crystal lattice. The variation is the same for phonons with q/q_{max} between 0.3 and 0.8, where q is the length of the phonon wave vector. The line widths are of such a magnitude that the derived phonon mean free paths vary from about 5 phonon wavelengths at 600°K to about 1.5 phonon wavelengths at 930°K. The line widths and accordingly the mean life time are the same for the longitudinal and the transverse vibrations. The observed multi-phonon spectra were found to agree with calculated differential cross sections in the incoherent approximation. (auth)

7177 INELASTIC NEUTRON SPECTRA FROM FERRO-ELECTRIC AND PARA-ELECTRIC $BaTiO_3$. I. Pelah (Weizmann Inst. of Science, Rehovoth, Israel and Atomic Energy Commission, Tel-Aviv, Israel) and I. Lefkowitz. p.601-4 of "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (In English)

Measurements were made at the Brookhaven slow chopper facility of the inelastically scattered spectra from ferroelectric and paraelectric $BaTiO_3$. The data were obtained from powdered $BaTiO_3$ at 28 and 150°C. Observed peaks in the optical region showed good agreement with those measured by infrared methods. Several authors reported absorption peaks at about 495 and 340 cm^{-1} which compare with our observed values of 450 and 337 cm^{-1}. An additional peak was found at 766 cm^{-1} which compares with maxima reported by P. Turlier et al, in the reflectance spectra of ceramic $BaTiO_3$ at 779 cm^{-1}. An observed peak in the neutron spectra at 235 cm^{-1} compares with Last's predicted peak for ν_3 of 225 cm^{-1}. Last's prediction of this mode was based on his infrared measurement of $\nu_1 = 500$ cm^{-1} and $\nu_2 = 340$ cm^{-1} and on a simple model using available specific heat data for $BaTiO_3$. Poor chopper resolution and insufficient statistics at the low wave number region did not permit corroboration of the low frequency mode ($\simeq 12$ cm^{-1}) predicted by Cochran in his recent complete treatment of a ferroelectric as a problem in lattice dynamics. Two peaks were observed in the acoustic region at about 113 and 78 cm^{-1}. Little change was noted between the spectra obtained from the paraelectric and ferroelectric forms of the $BaTiO_3$. This also was in agreement with results obtained by infrared techniques. (auth)

7178 MEASUREMENTS OF NEUTRON SPECTRA IN WATER, POLYETHYLENE AND ZIRCONIUM HYDRIDE. R. B. Walton, J. R. Beyster, J. L. Wood, and W. M. Lopez (General Atomic Div., General Dynamics Corp., San Diego, Calif.). p.613-26 of "Inelastic Scattering of Neutrons in Solids and Liquids." Vienna, International Atomic Energy Agency, 1961. (In English)

Neutron spectra were measured in pure and poisoned moderators under essentially infinite medium conditions. These spectra are expected to depend sensitively on molecular binding in the moderator and therefore serve to check theoretical methods for predicting low energy scattering phenomena. The experimental apparatus consisted of the high intensity pulsed neutron source, a large sample of moderator, a 16-m collimated flight path, and a bank of

boron trifluoride detectors. The spectrum of neutrons emitted from a small re-entrant hole located 10 to 20 cm from the fast neutron source was measured by pulsed beam time-of-flight techniques. The relative efficiency of the neutron detector bank was obtained by comparing its response with that of $1/v$ neutron detectors. Neutron spectra were measured in pure water and in water poisoned with boron, cadmium, and samarium. Spectra were measured in pure polyethylene, and polyethylene poisoned homogeneously with $1/v$ absorber (boron). Neutron spectra in graphite, beryllium oxide, and zirconium hydride poisoned with boron were also determined. Total cross section measurements in the energy range from 0.002 to 10 ev were carried out for the moderators and neutron absorbers used for these spectral studies so that accurate cross-section data would be available for use in theoretical predictions of the spectra. In all cases free atom predictions of the neutron spectra are in disagreement with experiment. Present theoretical techniques for handling neutron slowing down in water appeared to be adequate for many purposes as evidenced by the bound hydrogen predictions of neutron spectra. Polyethylene spectra were somewhat harder than water spectra, indicating increased binding of the hydrogen in this moderator. Since predictions of the slowing-down properties of polyethylene are not available, infinite-medium spectra could not be calculated. The measured spectra in zirconium hydride indicated positively the influence of the Einstein levels and of the strong hydrogen binding. Graphite and beryllium oxide spectra showed strong effects due to molecular binding, somewhat greater than current theoretical methods predict. (auth)

Particle Accelerators

Refer also to abstracts 6622 and 7259

7179 (CEA-tr-X-398) ELEMENTS DU PROJET D'UN SYNCHROTRON A PROTONS DE 12 GeV. (Factors in the 12-Gev Proton Synchrotron Project). G. Sacerdoti (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratori Nazionali, Frascati). Translated into French from C.N.E.N. Internal Note No. 63. Dec. 15, 1960. 65p.

The initial parameters of a projected 12-Bev proton synchrotron are tabulated, and the maximum values for the characteristics of the beam, magnet, feed, h-f source, and injector are calculated. In an appendix the magnetic field in the ferrites of the resonating cavity, the maximum dimensions of a resonating cavity and the cavity losses, and the dimensions of the h-f installation are calculated. (J.S.R.)

7180 ON DECREASING THE LENGTH AND DUTY CYCLE OF CYCLOTRON ION BEAM BUNCHES. N. I. Venikov. Atomnaya Energ., 11: 421-5(Nov. 1961). (In Russian)

Results of calculations and experimental investigations are presented on changing the length of the beam pulse on a cyclotron target. The possibility of influencing the repetition rate of the beam bunches by high-frequency electrostatic deflection is examined, whereby an electrode is placed inside the accelerating dee along the orbit of the first half-turn of the ions. Calculations and experiments were carried out for deuterons accelerated to 10 Mev in the 1.5-meter cyclotron. It was found that the requirements of stable beam operation do not allow an appreciable shortening of the pulses, whereas they do allow them to be lengthened by about a factor of two. The first-orbit deflection system did not produce the desired result of lowering the repetition rate for reasonable beams. It is concluded that for such work deflection of the beam accelerated to its final energy is still the best method. (TTT)

7181 EXPERIMENTAL STUDY OF A LINEAR ACCELERATOR WITH AN ELECTRON PREBUNCHER. G. I. Zhileiko and D. A. Yakovlev. Atomnaya Energ., 11: 447-9 (Nov. 1961). (In Russian)

An accelerator provided with an electron prebuncher is discussed. This device is characterized by the fact that the phase of the incident electron cluster may be changed by means of a phase changer until injection of the cluster can be carried out simultaneously with the equilibrium phase. The input can be remotely controlled. The results indicated that the prebuncher exerts a positive effect on the operation of the accelerator. A correlation has been found between the width of the spectrum of the accelerated electrons, the output beam current and the phase of the high-frequency oscillations. At an angle lying between 20 and 40° the electron cluster of the prebuncher coincides with the equilibrium phase, resulting in lowest spectrum width and highest current while the phase ranging from −80 to −120° corresponds to the incidence of the cluster on a phase region with unsatisfactory conditions for prebunching. Use of the prebuncher, even with only a single resonator, increases the beam current about threefold and reduces the spectrum width by a factor of 3 to 4; the two-resonator system increases the current to an even greater extent but it requires greater precision in the experimental parameters and in general makes operation more difficult. (TTT)

7182 THE HIGH VOLTAGE ELECTROSTATIC GENERATOR OF CISE LABORATORIES. I. Iori, P. Principi, and T. Rossini (CISE, Segrate, Italy). Energia nucleare (Milan), 8: 758-69(Dec. 1961). (In Italian)

A 4.5-Mev electrostatic generator of the pressurized Van de Graaff type is described. The gas pressure, nitrogen with 20% carbon dioxide, is approximately 220 lb/in.^{2}, and the pressure tank is 18 ft long by 8 ft in diameter. Details of the construction and the results of trials are given. (auth)

7183 CISE'S 3.5 Mev ELECTOSTATIC ACCELERATOR. I. Iori, P. Principi, and T. Rossini (CISE, Segrate, Italy). Energia nucleare (Milan), 8: 770-6(Dec. 1961). (In Italian)

A 3.5 Mev electostatic ion accelerator is presented. Its peculiar characteristics are the accelerating tube, which can be completely disassembled, and the system for directly measuring all the working parameters. The working conditions are 50 μA ion current at 3.5 Mev. (auth)

7184 COMPARATIVE MEASUREMENTS AT VARIOUS EUROPEAN BETATRON STATIONS. J. Kretschko, H. Liesem, W. Pohlit, S. Rase, and A. Sewkor (Max-Planck-Institut für Biophysik, Frankfurt am Main). Fortschr. Gebiete Röntgenstrahlen u. Nuklearmed., 95: 553-64(Oct. 1961). (In German)

During a tour of European betatron stations the dosimeters used for high-energy therapy were compared with a standard dosimeter. The calibration factors for the different dosimeters in use are listed in tables. At the same time the spectral composition of the therapy beams was investigated. For this purpose the energy of the electrons was determined by measuring their range and by establishing threshold values for nuclear photoreactions and depth dose curves in plexiglass with different energies. (auth)

7185 A PUMPED KLYSTRON AMPLIFIER AND RF POWER SYSTEM FOR THE INJECTOR LINAC OF 1 BeV

ELECTRON SYNCHROTRON. Akira Miyahara (Tokyo Univ.). J. Phys. Soc. Japan, 16: 2567-73(Dec. 1961). (In English)

A power klystron amplifier and its driver system for a 6-Mev linear electron accelerator are described. The klystron is evacuated during its running by two specially designed oil diffusion pumps connected in series. Without using a liquid nitrogen trap the klystron works stable with the peak power output of 2 to 3 Mw. The average life of the oxide-coated cathode was more than 500 hours. To keep a good frequency stability, a feed back oscillator with an invar cavity and a traveling wave tube is used as a master oscillator. The output of this oscillator is 1 to 2 w at 2759 Mc, with the fluctuation being less than 20 kc. The output signal of the oscillator is amplified by a pulsed traveling wave tube amplifier to drive the power klystron. (auth)

7186 CONTROL OF RADIATIONS AROUND THE SATURNE PROTON SYNCHROTRON. H. Joffre, J. Lamberieux, and A. Stirling (Centre d'Etudes Nucleaires, Saclay, France). Minerva nucleare, 5: 167-83(Aug. 1961). (In Italian)

The characteristics of the Saturn proton synchroton are briefly presented, and the main principles of radiation control near the accelerator are illustrated. The apparatus for detection of radiations is described. The results of measurements of irradiation are presented, and the mechanisms which are being constructed for better protection of the accelerators are described. (auth)

7187 SAFETY AND DOSIMETRY NEAR HIGH ENERGY ACCELERATORS WITH PULSED FLUX. Mario Ladu (Comitato Nazionale per l'Energia Nucleare, Frascati, Italy). Minerva nucleare, 5: 184-6(Aug. 1961). (In Italian)

The problems of radioprotection and dosimetry near high energy accelerators are illustrated and discussed, especially those connected with shielding, mixed-field detection, and evaluation of the biological dose. (auth)

7188 SHIELDING AGAINST ENERGETIC NEUTRONS OF A RELATIVISTIC ISOCHRONCYCLOTRON. H. J. Langmann (Kernforschungszentrum, Karlsruhe, Ger. and Universität, Heidelberg, Ger.). Nukleonik, 3: 201-4(Oct. 1961). (In German)

The important specifications necessary for calculating the neutron shielding required for a relativistic isochronous cyclotron were compiled. The intensity and the energy distribution of neutrons, the relaxation length of very fast neutrons in water, concrete, iron, lead, and other absorber materials, and the modification of the primary neutron spectrum by the shield were especially reported. (tr-auth)

7189 EXPERIMENTS WITH ELECTRIC SIMULATOR FOR LINEAR ACCELERATOR. O. A. Val'dner and I. M. Vitenberg. Pribory i Tekh. Ekspt., 6: No. 4, 25-6(July-Aug. 1961). (In Russian)

Descriptions are given of an electrical simulator for determining electron motion in a linear accelerator. (tr-auth)

7190 LINEAR ACCELERATOR FOR 3 MEV ELECTRONS. O. A. Val'dner and A. A. Glazkov (Moscow Inst. of Engineering Physics). Pribory i Tekh. Ekspt., 6: No. 5, 26-8(Sept.-Oct. 1961). (In Russian)

Descriptions are given of a linear accelerator developed for use in industry. The accelerated electron energy is 3.1 Mev, the beam current is 200 μa, the γ intensity with an optimum target is 260 r/min. The accelerator specifications are included. (tr-auth)

Plasma Physics and Thermonuclear Processes

Refer also to abstract 6547

7191 (AD-257296) ELECTROMAGNETIC WAVE PROPAGATION AND RADIATION CHARACTERISTICS OF ANISOTROPIC PLASMAS. Down-Range Anti-Ballistic Measurement Program (DAMP). (Radio Corp. of America. Missile and Surface Radar Div., Moorestown, N. J.). Apr. 1961. Contract DA-36-034-ORD-3144 RD. 79p.

A study was made of the electromagnetic properties of homogeneous anisotropic plasmas. The propagation characteristics of electromagnetic waves in anisotropic plasmas were examined for propagation parallel to and perpendicular to the applied d-c magnetic field. The existence of very low frequency pass-bands due to ion effects was noted. Faraday rotation due to the earth's magnetic field was considered for the ionosphere and the plasma sheath of a reentry vehicle. A generalized and exact form of Kirchhoff's law was used to obtain the absorptivity of a plasma from its electromagnetic properties. The absorptivity of an isotropic and anisotropic plasma slab was computed for normal incidence and the effects of electron collision frequency, slab thickness, stop-bands and boundary effects on the radiation spectrum are presented. (auth)

7192 (AFOSR-1625) IONIZATION EXPERIMENT ON AN ELECTRODELESS DISCHARGE WITH TOROIDAL GEOMETRY. J. E. Chambers, H. G. Loos, K. J. Park, and R. P. Treat (Giannini Scientific Corp., Santa Ana, Calif.). Aug. 1961. Contract AF49(638)-1014. 45p.

Measurements were made concerning the initial breakdown of a gas subjected to an electrodeless discharge in a toroidal geometry with the magnetic field in the longitudinal direction. The current through a ring conductor embracing the toroidal discharge tube established the rotational transform required for plasma equilibrium. Smear photographs of the discharge were made, looking through the discharge tube in a plane which passes through the torus axis. Simultaneous measurements of light intensity (by photomultipliers) and of the magnetic field in the gas showed that the initial breakdown occurs at a time when the magnetic field is zero. The data allowed an interpretation in which the plasma has the form of a shell. Marginal breakdown conditions were measured. (auth)

7193 (AFOSR-1782) BASIC STUDIES IN MAGNETOHYDRODYNAMICS. Final Report, May 1, 1957 to October 31, 1961. Richard M. Patrick (Avco Corp. Avco-Everett Research Lab., Everett, Mass.). Oct. 1961. Contract AF49(638)-61. 40p.

The research described was directed toward obtaining a basic understanding of magnetohydrodynamics. The initial studies led to three possible applications for magnetohydrodynamics which in turn led to three categories of research. The first application appeared in connection with the problem of high-altitude, very high velocity flight. The second application was plasma propulsion. The third category was the production of a very high temperature collision-free plasma. (auth)

7194 (AFOSR-1896) THE STABILITY OF THE PINCH WITH ANISOTROPIC PRESSURE. Technical Note BN-269. R. K. Jaggi (Maryland. Univ., College Park). Dec. 1961. Contract AF18(600)1315. 30p.

A dispersion equation was obtained for the stability of the pinch from the hydromagnetic equations supplemented

by an equation for the pressure tensor of the ions. The dispersion equation was obtained for the marginal instability case only. It was observed that this dispersion equation coincides with the dispersion equation obtained from the Chew, Goldberger, and Low equations for the marginal instability case. It was concluded that the region of stability predicted from the equations that were used is slightly more than that given by the kinetic equation used by Chandrasekhar, Kaufmann, and Watson. (auth)

7195 (ARL-34) RESEARCH ON INTERNAL FLOW IN MAGNETOHYDRODYNAMICS AND PLASMA-DYNAMICS. C. C. Chang, J. T. Yen, T. S. Lundgren, and H. B. Atabek (Minnesota. Univ., Minneapolis). Mar. 24, 1961. Contract AF33(616)-6037. 13p.

A group of five related papers are summarized. Each is concerned with the parallel, steady or unsteady, flow of an incompressible, viscous, electrically conducting fluid through a duct with a steady transverse applied magnetic field. The fluid is caused to flow across the magnetic field lines by applying a pressure gradient or by moving portions of the walls. The effects of duct geometry, wall conductivity and unsteadiness were investigated. (auth)

7196 (ARL-69) MAGNETOHYDRODYNAMIC EFFECTS ON EXOTHERMAL WAVES. I. THEORETICAL PROBLEMS ON A MACROSCOPIC SCALE. II. EXPERIMENTAL STUDY WITH HYDROGEN-OXYGEN DETONATION WAVES. Michael C. Fong, Loren E. Bollinger, and Rudolph Edse (Ohio State Univ., Columbus). Oct. 1960. Contract AF33(616)-5615. 90p.

Various problems associated with the macroscopic magnetohydrodynamic effects on an exothermal wave were treated on the basis of one-dimensional flow considerations. A steady exothermal wave traveling in an ionized medium under the influence of a transverse magnetic field was found to display properties similar to those of a classical detonation or deflagration wave. For a hydromagnetic exothermal wave, it was found that a discontinuity either in thermodynamic quantities or in magnetic field strength appears as soon as the flow reaches the transition region. Solutions for an ionization-inducing exothermal wave passing into a transverse magnetic field of finite extent were obtained. Heat from chemical reactions and induced ponderomotive forces would either obstruct or accelerate the flow depending on whether the initial flow is subsonic or supersonic. The influence of a transverse magnetic field on the transition process from deflagration to detonation was discussed. Following Markstein's analysis of flame disturbances, a small-perturbation solution for the stability of flames with magnetohydrodynamic effects was obtained. A set of flame stability criteria developed from this theory indicates that a transverse magnetic field may increase or decrease the flame stability depending on the flame curvature and the disturbance wave length. The effect of a steady-state and oscillating (60 cycles per second) transverse magnetic fields upon the formation of detonation waves was studied experimentally with various hydrogen–oxygen mixtures in a 50-mm diameter cylindrical tube. Results of this preliminary study show that d-c and a-c fields inhibit the formation of a detonation wave in these combustible mixtures. A very modest a-c field (30 gauss) caused a greater inhibition than a 1000 gauss d-c field when the magnet coils were located in the same region of the induction zone. (auth)

7197 (CEA-1995) INTERACTION D'ONDES ELECTROMAGNETIQUES A POLARISATION CIRCULAIRE AVEC UN PLASMA. (The Interaction of Circularly Polarized Electromagnetic Waves with a Plasma). T. Consoli, R. Legardeur, and L. Slama (France. Commissariat à l'Énergie Atomique. Centre d'Etudes Nucleaires, Saclay). 1961. 42p.

The interactions of left and right handed circularly polarized waves with a plasma were studied. The individual trajectories of charges of both signs were traced with an analogic simulator. Applications to plasma heating and diagnostics were deduced. (auth)

7198 (CEA-2050) MICROSTRICTION I ET II. (Microstriction I and II). M. Alidieres, R. Aymar, P. Jourdan, and A. Samain (European Atomic Energy Community and France. Commissariat à l'Energie Atomique. Centre d'Études Nucléaires, Saclay). 1961. 54p.

A certain quantity of gas was enclosed between two coaxial glass tubes (diameters 67 and 87 mm). In this annular space thus formed existed a permanent magnetic configuration, whose lines of force were perpendicular to the surface of the tubes (0–500 gauss). An electric field was then produced by induction such that its lines of force were circles whose axis coincided with that of the tubes (200 V/cm). The electric field lasted for 0.5 μsec. This field ionized the gas and caused an electric current to flow perpendicularly to the magnetic field. The corresponding Laplacian force accelerated the plasma along the axis of the tubes. In the first series of measurements, the discharge characteristics in the absence of a permanent field were studied. The plasma movement in the permanent magnetic field induced in this latter a back-e.m.f. By taking into account the discharge resistance the electric current and the forces tending to accelerate the plasma could be evaluated. The efficiency of the acceleration process was measured. It passed through a maximum for a certain value of the permanent magnetic field. The experimental results were compared with the simple model described above. (auth)

7199 (MATT-98) THE THERMAL DECOMPOSITION OF LITHIUM NITRATE. L. E. Gastwirt and E. F. Johnson (Princeton Univ., N. J. Plasma Physics Lab.). Aug. 1961. Contract AT(30-1)-1238. 217p.

The thermal decomposition of lithium nitrate above the melting point is studied as part of a program seeking to evaluate this salt as a possible blanket material for fusion reactors. A theoretical study is undertaken which defines the decomposition thermodynamically and furnishes equilibrium constants for reactions pertinent to the decomposition. The value of this study is limited, however, by the lack of thermochemical data, which necessitated the use of various estimating methods, and by the possibility of kinetic limitations upon the attainment of chemical equilibrium. The experimental study of the decomposition is carried out at 500 and 600°C in a specially constructed vessel. The course of the decomposition is followed by periodic sampling of the gas phase; the melt is also sampled, thus furnishing equilibrium constants for comparison with the estimated values. The experimental study generally confirmed the estimating procedures, and as a result values are advanced for the standard entropies of formation of solid $LiNO_3$ and $LiNO_2$ at 298°K as well as for the standard heat of formation of $LiNO_2$ at 298°K. In addition, the study served to identify a kinetic limitation upon the decomposition, even at temperatures as high as 600°C. Even in the absence of any kinetic limitations, the use of lithium nitrate as a blanket material for fusion reactors remains a promising possibility. (N.W.R.)

7200 (TID-13957) MICROSCOPIC AND MACROSCOPIC MODELS IN PLASMA PHYSICS. Harold Grad (New York Univ., New York. Inst. of Mathematical Sci-

ences). Aug. 15, 1961. Contract AT(30-1)-1480. 53p. (MF-19)

Talk presented at Symposium on Electromagnetics and Fluid Dynamics of Gaseous Plasma, Polytechnic Inst. of Brooklyn, April 1961.

In choosing a model to describe the behavior of a plasma, a balance must be maintained between the simplicity of a macroscopic description and the detail in a microscopic description. In an ordinary gas, the criterion for behavior as a continuum is that the mean-free-path be small. In a plasma there is a similar criterion; other lengths (Debye, Larmor) may complicate the macroscopic equations but will not destroy their validity. An entirely different criterion (in a collisionless plasma) is that the Larmor radius be small. A consistent treatment of just the lowest order guiding-center particle motion is sufficient to yield, with a minimum of computation, both a microscopic theory (guiding-center gas) and a macroscopic continuum theory (guiding-center fluid). A comparison shows why certain types of arguments conventionally phrased in microscopic terms are exactly equivalent to a potentially less exact macroscopic analysis. (auth)

7201 (UCRL-6675-T) COMPOSITE TRIP REPORT, MUNICH AND SALZBURG CONFERENCES TOGETHER WITH ASSOCIATED SIDE TRIPS. N. Christofilos, F. H. Coensgen, S. A. Colgate, H. P. Furth, J. Killeen, E. J. Lauer, W. B. Kunkel, W. A. Newcomb, R. F. Post, and C. M. Van Atta (California. Univ., Livermore. Lawrence Radiation Lab.). Oct. 27, 1961. Contract [W-7405-Eng-48]. 41p.

Staff members of the Lawrence Radiation Lab. report on their impressions of two conferences and on their visits to various European laboratories conducting plasma and thermonuclear research. The two conferences are the Fifth International Conference on Ionization Phenomena in Gases (Munich, Aug. 28 to Sept. 1, 1961) and the IAEA Conference on Plasma Physics and Controlled Nuclear Fusion Research (Salzburg, Sept. 4 to 9, 1961). (D.L.C.)

7202 (USCEC-79-204) LOW FREQUENCY RADIATION FROM AN ELECTRIC DIPOLE IN A COLD ANISOTROPIC PLASMA. Hans H. Kuehl (University of Southern California, Los Angeles. Engineering Center). Nov. 1961. Contract AF49(638)-522. 12p. (AFOSR-1809)

Expressions for the electromagnetic radiation from an electric dipole in an infinite cold anisotropic plasma are presented under the condition that the operating frequency is much less than the ion gyrofrequency. It was found that the major portion of the radiation is concentrated along the direction of the magnetostatic field. (auth)

7203 CONFINED ELECTRON STREAMS IN A PLASMA. H. Alfvén (Royal Inst. of Tech., Stockholm). Arkiv Fysik, 20: 389-92(1961). (In English)

A type of pinch current referred to as an electron stream is discussed. The particles move under the action of their own magnetic field. There is no electric field and the ion temperature is zero, everywhere. Motions of the particles are described and limiting conditions and functions are given. Comparisons with similar phenomena are made. (L.N.N.)

7204 EXPERIMENTAL STUDY OF THE STARTING OF LAMINAR FLOW IN AN ELECTRICALLY CONDUCTING LIQUID IN A TUBE OF RECTANGULAR CROSS SECTION, IN THE PRESENCE OF A MAGNETIC FIELD. Étienne Crausse, René Causse, and Yves Poirier (Faculté des Sciences, Algiers). Compt. rend., 253: 2463-5(Nov. 27, 1961). (In French)

The startup of laminar flow in an electrically conducting liquid in a uniform magnetic field that is normal to the flow is studied empirically. Curves are obtained for various values of the driving pressure and magnetic field. (tr-auth)

7205 CONFINEMENT OF PLASMA PARTICLES IN A CORRUGATED MAGNETIC FIELD. Tsuneo Amano (Kyoto Univ.). J. Phys. Soc. Japan, 16: 2517-25(Dec. 1961). (In English)

Particle orbits in a corrugated magnetic field having neutral points, at which the magnitude of the field vanishes, are studied. An axially symmetric case is treated in detail and the effect of the curvature is considered. It is shown that the charged particles do not escape from the neutral points when they are situated several Larmor radii inside the line of force passing through the neutral points. The possibility of the confinement of a hot plasma in a general corrugated field is discussed. (auth)

7206 PLASMA OSCILLATIONS AND LANDAU DAMPING IN A RELATIVISTIC GAS. B. Buti (Univ. of Chicago). Phys. Fluids, 5: 1-5(Jan. 1962).

The problem of Landau damping in plasma oscillations is studied in a relativistic gas and the asymptotic forms of the dispersion relation and the damping coefficient are obtained in the nonrelativistic as well as in the relativistic limits. In the relativistic limit it is found that while the damping is very strong in the case where the phase velocity is small compared to the velocity of light, it is absent when the phase velocity exceeds the velocity of light. Moreover, in the former case, in the extreme relativistic limit the damping becomes independent of the plasma temperature. (auth)

7207 LANDAU DAMPING AND THE ATTENUATION OF WHISTLERS. F. L. Scarf (Space Tech. Labs., Los Angeles and Univ. of Washington, Seattle). Phys. Fluids, 5: 6-13(Jan. 1962).

Transverse electromagnetic oscillations in a gyrotropic plasma exhibit Landau damping when the wave is not monochromatic. The dependence of the damping on the equilibrium distribution and the boundary (or initial) values is investigated. The resulting dispersion relation is interpreted by examining the response of a single free electron to an incident wave. It is shown that the damping mechanism is associated with the Doppler shift caused by the thermal distribution, so that some particles are in cyclotron resonance for any laboratory frequency. The correlation of whistler data with this complex dispersion relation can be used to evaluate electron temperatures at several earth radii; a specific numerical example gives $T \approx 10^5$ °K at $R \approx 4R_e$ (geocentric). (auth)

7208 STABILITY OF THIN ELECTRON LAYERS. V. Kelvin Neil (Univ. of California, Livermore). Phys. Fluids, 5: 14-21(Jan. 1962). (UCRL-6463)

An instability that consists of a bunching transverse to the directed motion of an infinitely thin layer of electrons is investigated theoretically. The initial model is a plane sheet, infinite in extent, and neutralized by positive ions. This configuration is found to be unstable if all electrons travel with the same relativistic velocity. If the electrons are monoenergetic, but have a small angular spread in velocities, a criterion for stability is obtained that places a lower limit on the spread. This limit is directly proportional to the wavelength of the perturbation. The theory is also applied to a thin cylindrical sheet inside a perfectly conducting cylinder. The system is infinite in the axial direction, and the electrons move in the azimuthal direction. In the absence of axial velocity, the instability is present as in the plane sheet. Considering a spread in axial velocity leads to a stability criterion independent of perturba-

tion wavelength. A numerical example, employing the proposed parameters of the Astron device, indicates that an angular spread of about 60° is necessary for stability. (auth)

7209 SCREW INSTABILITY OF A PLASMA COLUMN. F. C. Hoh (Royal Inst. of Tech., Stockholm). Phys. Fluids, 5: 22-8 (Jan. 1962).

It is known that the positive column is unstable in a strong longitudinal magnetic field. Hence, the main features of Kadomtsev and Nedospasov's stability criterion are derived from simple physical arguments, and the mechanism responsible for instability is thus shown in a quantitative way. In particular, the perturbed radial potential distribution can be related to the perturbed density distribution, and hence need not be assumed. It turns out that this screw instability is a new and important type of instability hitherto not considered. The instability mechansim is not very sensitive to the degree of ionization, and hence may also be expected to be operative in highly ionized plasma columns. Possible connections with the instabilities observed in the Stellarator and the Zeta machine are discussed. An attempt is also made to explain regular oscillations observed in a toroidal discharge in terms of the present theory. (auth)

7210 DISPERSION OF ION CYCLOTRON WAVES IN MAGNETOPLASMAS. A. G. Engelhardt and A. A. Dougal (Univ. of Illinois, Urbana). Phys. Fluids, 5: 29-37 (Jan. 1962).

Dispersion of waves propagated at frequencies near the ion cyclotron frequency in collision-dominated plasmas subjected to axial magnetic fields is investigated. Radial and axial propagation constants, satisfying Maxwell's equations, and including the contributions of binary elastic ion-ion and ion-electron interparticle forces to an ion conductivity tensor, are calculated. Elements of the ion conductivity tensor are found analytically by expressing the ion distribution function in the Boltzmann equation as a series of orthogonal Laguerre polynomials in velocity space with time-dependent expansion coefficients. Right-handed and left-handed elliptically polarized waves are found from a numerical solution for a range of values of the ion cyclotron frequency about the fixed wave frequency of 7.62 Mc. The axial wavelengths λ_z^L, λ_z^R, and damping lengths λ_D^L, λ_D^R are calculated as functions of the magnetic field for a plasma density of 10^{21} m^{-3}, and temperature of 10^4, 10^5, and 10^6 °K. Enhanced dispersion occurs with increasing temperature. Stronger dispersion is associated with the left-handed elliptically polarized wave; for 10^5 and 10^6 °K, above resonance $\lambda_D^L \gg \lambda_z^L$, whereas below $\lambda_D^L \approx \lambda_z^L$. Ion-ion collisions broaden the resonance width and decrease absorption at resonance. (auth)

7211 DEVIATIONS FROM KINETIC EQUILIBRIUM IN A STELLARATOR PLASMA. J. G. Hirschberg and R. W. Palladino (Princeton Univ., N. J.). Phys. Fluids, 5: 48-51 (Jan. 1962). (MATT-87)

The increase in Doppler temperature with charge number, found in stellarators, was remeasured with improved precision for observation parallel to the lines of force. No dependence on position was found, and the results are ascribed tentatively to positive-ion waves parallel to the magnetic field. (auth)

7212 CERENKOV RADIATION SPECTRA FOR A COLD MAGNETOACTIVE PLASMA. Philip S. Johnson (U. S. Army Signal Research and Development Lab., Fort Monmouth, N. J.). Phys. Fluids, 5: 118-20 (Jan. 1962).

The macroscopic theories of Eidman and Allis concerning the radiation from an electron moving in a cold and homogeneous magnetoactive plasma and the topology of wave normal surfaces respectively are combined to yield a rather simple picture of a generalized Cherenkov radiation spectrum. (N.W.R.)

7213 INSTABILITY IN LOW-PRESSURE PLASMA DIFFUSION EXPERIMENTS. Gareth Guest (North Texas State Univ., Denton, Tex.) and Albert Simon. Phys. Fluids, 5: 121-2 (Jan. 1962). (GA-2707)

The diffusion rate across a magnetic field of the ions and electrons in a positive column has revealed the existence of a critical magnetic field for the onset of an anomalous diffusion rate across the magnetic field. It is shown here that an entirely similar mechanism may also be operative in the low-pressure region and that the instability which results may provide an explanation of various experimental anomalies. A typical illustration is a line source of plasma located on the central axis of a finite conducting cylindrical shell with an external magnetic field applied parallel to the axis. Plasma diffuses out in the radial direction and streams to the conducting end walls in the z direction. Space charge is maintained, however, by electric fields which adjust the streaming of electrons and ions out of the plasma to the end walls. This unequal rate of streaming of ions and electrons in the longitudinal direction provides a mechanism for separating the ion and electron screw perturbations in the Hoh-Lehnert model, thus permitting an instability to occur. From the calculations of this instability, it is found that a critical field is predicted which is directly proportional to the gas pressure, which is in the neighborhood of 2000 gauss for hydrogen gas at a pressure of 10^{-4} mm and with the temperature of the ions and electrons equal to 2 ev. The pitch of the unstable mode is always such that $j \times B$ points away from the cylindrical axis. In addition the screw rotates about the magnetic field in the same direction as a positive ion tends to rotate and with a frequency of 50,000 cps. (N.W.R.)

7214 ANALYSIS OF THE TRANSITION REGION BETWEEN A PLASMA AND ITS CONFINING MAGNETIC FIELD. James Hurley (New York Univ., New York). Phys. Rev., 124: 1307-8 (Dec. 1, 1961).

The problem considered is the transition region separating a uniform plasma from its confining magnetic field. The geometry chosen is one-dimensional. A self-consistent solution of Maxwell's equations and the equations of motion of the particles is obtained. An analytic solution is presented. The most interesting feature of the analysis is that the transition region is finite, the transition taking place entirely within the orbit of the particle of deepest penetration into the confining field. (auth)

7215 GRAVITATIONAL INSTABILITY OF A MAGNETIZED PLASMA. B. Lehnert (Royal Inst. of Tech., Stockholm). Phys. Rev. Letters, 7: 440-1 (Dec. 15, 1961).

The instability of a plasma supported under gravity by a magnetic field is considered in terms of fluid equations. Mathematical derivations are presented. (L.N.N.)

7216 ROTATIONAL TRANSFORMS IN A TOROIDAL FAST COMPRESSION EXPERIMENT. J. B. Taylor (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.) and K. V. Roberts. Phys. Rev. Letters, 8: 52-3 (Jan. 15, 1962).

It is shown that a vacuum field having the rotational transform necessary to prevent outward drift can be produced simply by shaping the inner surface of the single-turn coil. Thus, any Stellarator-type vacuum magnetic field may be produced in a fast apparatus. Advantages of using heating by a trapped reversed field rather than shock heating are discussed. (L.N.N.)

7217 ON THE CONTAINMENT TIME OF A PLASMA: AN IMPORTANT ERROR. Joseph Slepian. Proc. Natl. Acad. Sci. U. S., 47: 1883-4(Dec. 1961).

It is pointed out that the term $-nm_i\vec{V}_i \cdot \nabla\vec{V}_i$ is omitted in in the expression for containment time of a plasma (NSA, 15: 990). The expression should be $-nm_i\vec{V}_i \cdot \nabla\vec{V}_i + 1/c (\vec{j} \times \vec{B}) = \nabla p$. If the equation were correctly stated, it would be shown that there is no improvement in the time of a completely ionized simply connected plasma by subjecting the plasma to a magnetic field and that the equation, $p + B^2/8\pi$ = constant, is invalid. (L.N.N.)

7218 INJECTION OF A PLASMA FROM A POWERFUL PULSED DISCHARGE INTO VACUUM. Yu. D. Klebanov and V. I. Sinitsyn. Zhur. Eksptl'. i Teoret. Fiz., 41: 1340-6(Nov. 1961). (In Russian)

The plasma parameters under various conditions of operation of the injector are investigated by photographic, photoelectric, and thermal probe methods. A plasma formation containing a total number of charged particles of the order of 10^{16} is shown to move in vacuum with a velocity $\sim 10^7$ cm/sec. The injection time is 2 to 5 μsec. (auth)

7219 ON THE DETERMINATION OF THE VALUES OF $\omega_H\tau$ AND THE EFFECTIVE COLLISON FREQUENCIES OF PLASMA ELECTRONS AND IONS IN A MAGNETIC FIELD. E. I. Urazakov and V. L. Granovskii (Moscow State Univ.). Zhur. Eksptl'. i Teoret. Fiz., 41: 1375-7 (Nov. 1961). (In Russian)

The magnitude of $\omega_H\tau$ for ions and electrons of a plasma column in a longitudinal magentic field can be determined with two plane probes (a single and double one) by measuring the radial and azimuthal diffusion currents. The values thus obtained can be used for determining the mean collision frequencies of electrons and ions. Examples of such measurements in argon are presented at various gas pressures. The derived data are compared with calculated values. (auth)

7220 FORMATION OF A CURRENT CHANNEL IN A GAS DISCHARGE IN A WEAK MAGNETIC FIELD. A. P. Babichev, A. I. Karchevskii, Yu. A. Muromkin, and V. V. Sokolskii. Zhur. Eksptl'. i Teoret. Fiz., 41: 1378-81(Nov. 1961). (In Russian)

The configuration of a strong current toroidal discharge in a weak magnetic field is experimentally investigated for a constant magnetic flux in the liner cross section and constant and variable longitudinal fields at the discharge periphery. It is shown that the experimentally observed formation of a current channel which superficially resembles the pinch effect can be described in the case of constant as well as variable external magnetic fields by a stationary forceless discharge model. (auth)

7221 THE DISPERSION EQUATION FOR AN EXTRAORDINARY WAVE MOVING IN A PLASMA ACROSS AN EXTERNAL MAGNETIC FIELD. Yu. N. Dnestrovskii and D. P. Kostomarov (Moscow State Univ.). Zhur. Ekstpl' i Teoret. Fiz., 41: 1527-35(Nov. 1961). (In Russian)

A general qualitative investigation is made of the nonrelativistic dispersion equation for extraordinary and plasma waves moving in a plasma transversely to an external magnetic field. The frequency range in which the waves can move without attenuation is established. The conclusion drawn by some authors that in the neighborhood of each cyclotron resonance there exist capacity gaps is shown to be incorrect. The regularities established are illustrated by results of a numerical solution of the dispersion equation. (auth)

7222 CYCLOTRON RESONANCE IN A VARYING MAGNETIC FIELD. V. N. Lugovoi (Lebedev Inst. of Physics, Moscow). Zhur. Eksptl'. i Teoret. Fiz., 41: 1562-5 (Nov. 1961). (In Russian)

The electric conductivity tensor for an electron gas (plasma or semiconductor in the conductivity band) in a magnetic field with a variable (harmonic) component parallel to the constant component is calculated. If the electric field induced by the variable magnetic field is comparable to the characteristic plasma field, the analysis will be valid only for $p\tau \gtrsim 1$ (p is the cyclic frequency of variation of the variable magnetic field component and τ is the effective time the electron traverses mean free path). It is shown that under these conditions the absorbing properties of the medium appreciably depend on the variable component of the magnetic field. Contrary to the opinion previously expressed, negative absorption is impossible. (auth)

7223 ACCELERATION OF IONIZED GAS CLOUDS WITH SELF MAGNETIC FIELD SCATTERING ELECTRON FLUX. G. A. Askar'yan (Lebedev Inst. of Physics, Moscow). Zhur. Eksptl'. i Teoret. Fiz., 41: 1632-3(Nov. 1961). (In Russian)

Acceleration of a plasma with a proper magnetic field scattering the incident electron flux is considered. Two modes of increasing the amount of energy taken away from the electrons are indicated: multiple scattering on the magnetized plasma and application of induction inertia (weight increasing) of the electrons of a powerful current. It is noted that the effect may be employed in plasma accelerators and that it may occur in astronomical processes. (auth)

Shielding

7224 (APEX-230) GE-ANPD METHODS OF SHIELD DESIGN. J. G. Carver, W. E. Edwards, and J. E. MacDonald (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Dec. 30, 1955. Contracts AF33(038)-21102 and AT(11-1)-171. 149p.

A detailed description is presented of methods of shield analysis and design used by the GE-ANPD shielding group as of November 1955. Complete sets of working equations are included, together with derivations of the more important relationships. Basic assumptions and limitations of methods are discussed, as are contemplated changes and improvements under development. Tables and graphs of useful nuclear data are presented in the appendices. (auth)

7225 (APEX-293) FAST NEUTRON AND GAMMA RAY POINT-KERNEL COMPUTER PROGRAM. J. E. MacDonald and W. E. Edwards (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). June 30, 1955. Contracts AF33(038)-21102 and AT(11-1)-171. 29p.

Programs for calculating direct-beam fast neutron and gamma dose rates in and around cylindrical shield regions coaxial with cylindrical source regions were coded for the IBM 701. Checkout of the fast neutron program using the Albert-Welton point kernel and the present status (up to June, 1955) of the gamma program are discussed. Instructions for using the fast neutron program are included. (auth)

7226 (NEPA-1079) SHIELD WEIGHTS FOR MANNED AIRCRAFT. C. S. Dauwalter (Fairchild Engine and Airplane Corp. NEPA Div., Oak Ridge, Tenn.). Aug. 10, 1949. Decl. July 18, 1961. Contract [W-33-08-ac-14801(16250)]. 36p.

A study was made to supply approximate shield weights and dimensions for current NEPA aircraft and powerplant design studies. Shields for both liquid-metal and gas-cooled reactors were considered. Graphs and drawings are included. (auth)

7227 SIMPLE AND OBVIOUS DETERMINATION OF THE CONSTRUCTION FACTORS IN SHIELDING LAYERS. Emin Beynam. Nukleonik, 3: 204-10(Oct. 1961). (In German)

The construction factor was determined with the help of collision centers or collison groups, and simplification possibilities are given. The approach aims at a clear representation of the scattering process and should be supplemented by more accurate calculations of the energy displacement. (tr-auth)

Theoretical Physics

7228 NOTE ON THE POLARIZATION IN FOUR-FERMION INTERACTIONS. Jean Nuyts (Université Libre, Brussels, and Faculté des Sciences, Orsay, France and Paris). Bull. classe sci. Acad. roy. Belg., (5) 47: 566-84 (1961). (In French)

On the basis of the Bouchiat-Michel formula for the polarization of relativistic spin-1/2 particles, a generalization is derived that permits a covariant description of the 2×2 polarization matrix density of fermions in arbitrary reference systems. The formalism is of greatest value in the case in which the ingoing and outgoing fermion configurations are the same. (tr-auth)

7229 ELECTROMAGNETIC INTERACTIONS OF THE YANG-MILLS FIELD. Kuo-Hsien Tzou. Compt. rend., 253: 2645-7(Dec. 4, 1961). (In French)

A formulation is found that is compatible with the interaction of the Yang-Mills field with the electromagnetic field. The interaction is found to be neither simply minimal, nor completely linear. (tr-auth)

7230 REMARKS ON THE ROLE OF THE THEORY OF CUMULANTS IN THEORETICAL PHYSICS. Ph Choquard (Battelle Inst., Geneva) and Université, Lausanne, Switzerland). Helv. Phys. Acta, 34: 508-14(1961). (In French)

In his "Theory of Observations," T. N. Thiele has introduced the semi-invariants (or cumulants) into statistical mathematics. These functions, endowed with remarkable properties, have found only few applications in statistics. It is, however, surprising that their interest for theoretical physics has not been recognized from the origin of quantum mechanics. In order to indicate this, a generalized definition of cumulants is given which is adaptable to functional analysis, and some problems of theoretical physics where their utilization appears natural are mentioned. It appears that an implicit use of cumulants has been made in modern theories. (tr-auth)

7231 GENERAL EQUIVALENCE THEOREM IN VECTOR FIELD THEORY. P. A. Ionides (Imperial Coll. of Science and Tech., London). Nuclear Phys., 28: 662-4 (1961). (In English)

A general equivalence theorem is derived for vector fields invariant under Lie groups, which shows that they are not renormalizable unless the bare mass vanishes. (auth)

7232 A GENERALIZED HAMILTONIAN DYNAMICS FOR RELATIVISTIC PARTICLES WITH SPIN. [PART] I. J. B. Hughes (Royal Coll. of Advanced Tech., Salford, Eng.). Nuovo cimento (10), 20: Suppl. No. 2, 89-111(1961). (In English)

A generalized Hamiltonian dynamics for classical relativistic particles with spin is developed. It is assumed that the motion of the particle can be described in terms of the position coordinates of some point P within the particle, plus the direction cosines of an orthogonal tetrad of vectors that form a moving frame of reference with origin at P. It is further assumed that the motion of the particle can be expressed in terms of its momentum, external angular momentum, and spin angular momentum. It is found that the Frenet frame can be used as the moving frame of reference. (T.F.H.)

7233 INELASTIC COLLISIONS AND THRESHOLD EFFECTS. L. Fonda (Inst. for Advanced Study, Princeton, N. J.). Nuovo cimento (10), 20: Suppl. No. 2, 116-45(1961). (In English)

The anomalous energy dependence observed in the scattering and reaction cross sections near the thresholds of inelastic processes is studied. It is found that the threshold behavior of the Green's function that gives the propagation of probability in the newly opened channel is the source of the anomalous effects in the complete multi-channel Green's function, and hence in the transition amplitudes. The anomalous effect is studied for non-Coulomb and Coulomb interactions, in cases in which any number of particles is produced. The importance of these effects in the determination of the spins and relative parities of the reaction products, of scattering phase shifts, and of related cross sections, and in the search for new particles, is discussed. (T.F.H.)

7234 A GENERALIZED HAMILTONIAN DYNAMICS FOR RELATIVISTIC PARTICLES WITH SPIN. [PART] II. J. B. Hughes (Royal Coll. of Advanced Tech., Salford, Eng.). Nuovo cimento (10), 20: Suppl. No. 2, 148-56(1961). (In English)

A generalized Hamiltonian dynamics for classical relativistic particles with spin is considered, in which the motion of the particle is described in terms of the motion of some point P within the particle plus the directional cosines of an orthogonal tetrad of vectors that form a moving frame of reference with origin at P. The cosines may be chosen so as to satisfy the Frenet equations in 4-space; the frame of reference whose cosines satisfy these equations is called the Frenet frame. The representation of the particle in the Frenet frame is developed, and a method for including quantum effects is discussed. (T.F.H.)

7235 THE NUCLEON-NUCLEON POTENTIAL IN QUANTUM FIELD THEORY. [PART] I. R. Cirelli and G. Stabilini (Università, Milan and Istituto Nazionale di Fisica Nucleare, Milan). Nuovo cimento (10), 20: Suppl. No. 2, 157-220(1961). (In English)

A survey is presented of the major results obtained for the nucleon-nucleon potential within the framework of meson field theories. Various methods for formulating and constructing theoretical potentials are discussed, and the properties of the resulting potentials are reviewed. It is concluded that the one-pion exchange potential results found by different methods are quite consistent, but that attempts at formulating a two-pion exchange potential are premature because of uncertainties in corrections that must be applied. (T.F.H.)

7236 EQUATION OF STATE AT ULTRA-HIGH DENSITIES AND ITS RELATIVISTIC LIMITATIONS. Ya. B. Zel'dovich. Zhur. Eksptl'. i Teoret. Fiz., 41: 1609-15(Nov. 1961). (In Russian)

The most rigid equation consistent with relativity is $\rho = \epsilon \sim n^2$, $D \rightarrow c$ where ρ is the pressure, ϵ the energy volume density, n the baryon density, D the velocity of sound, and c the velocity of light. This equation obviously differs from the previously proposed asymptotic one $3\rho = \epsilon \sim n^{5}$, $D \rightarrow c/\sqrt{3}$. Baryon interaction via a vector field with nonvanishing mass is considered. It is shown (by considering pair baryon interaction as well as applying the field stress tensor) how the equation $\rho = \epsilon \sim n^2$ is realized in this case and how transition to the equation $3\rho = \epsilon$ takes place when the field quantum mass vanishes, as it does in electrodynamic case. (auth)

REACTOR TECHNOLOGY

General and Miscellaneous

7237 (ANL-6410) REACTOR LABORATORY EXPERIMENTS. William J. Sturm, ed. (Argonne National Lab., Ill.). Aug. 1961. Contract W-31-109-eng-38. 430p.

An exposition is presented comprising a basic set of experiments in reactor physics, engineering, and technology developed by the International Institute of Nuclear Science and Engineering. Twenty-two experiments are included in a program which may be divided into groups associated with the Argonaut Reactor, the AGN-201 Reactor, and with other reactors or auxiliary equipment. (J.R.D.)

7238 (APEX-291) REACTOR CONTROLS ANALYSIS. J. W. Thorson (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Aug. 1, 1956. Contracts AF33(038)-21102 and AT(11-1)-171. 30p.

The approach (up to August 1956) to reactor controls analysis, as carried out by the GE-ANPD, is summarized and reviewed. For purposes of illustration, the results of the HTRE No. 3 preliminary controls analysis are outlined. Uncertainties in existing methods lead to probable errors on the order of ± 30% in estimates of reactivity worth. Incorporation of undesirably large safety factors in a given design and resultant losses in performance are costly penalties for these uncertainties. A program of controls analysis methods development, which should reduce the current inherent errors considerably and improve the state of the art, is presented. (auth

7239 (DC-52-25-70) EVALUATIONS OF EFFECT OF UO_2 ON THE CORE STRENGTH OF STAINLESS STEEL FUEL ELEMENTS (TASK 7306). E. S. Funston (General Electric Co. Aircraft Nuclear Propulsion Project, Lockland, Ohio). May 12, 1952. Decl. July 18, 1961. Contracts AF33(038)-21102 and AT(11-1)-171. 14p.

A test procedure was established for evaluating the core strength of stainless steel fuel elements at temperatures to 1800°F. This evaluation, known as a transverse rupture test, measures the short time tensile stress required to rupture a specimen in a plane parallel to the surface of the sheet. The strength of commercial 309 stainless steel, 12 mils thick, was tested by this procedure and averaged 12,000 lbs/in^2 at 1800°F which value compares favorably with tensile strength data reported in the literature (11,500 psi). This value was compared against that obtained for fuel element sheet of the same thickness and consisting of a 4-mil cladding and a 4-mil core. The transverse rupture strength of the fuel element sheet, containing no uranium dioxide in the core, averaged 7500 lbs/in^2 at 1800°F and failure was through the core. This value, while low compared to the value reported above for the commercial sheet, certainly proves the existence of a strong stable structure. Indications are that the carbon, silicon and manganese present in commercial sheet, and absent from the core of fuel element sheet, may be partially responsible for the difference noted. When additions of uranium dioxide fuel are made to the core, particle size of the fuel, as well as concentration, affect structural strength. The optimum particle size of uranium dioxide grains ranges from 10 to 40 microns. Fuel addition of optimum particle size to the core decreases structural strength directly proportional to the volume of stainless steel displaced for concentration to 40 weight per cent UO_2. Further increase in fuel concentration results in a sharp decrease in strength. Fuel sheet containing more than 70 weight per cent UO_2 in the core cannot be processed satisfactorily. (auth)

7240 (DC-56-8-140) FABRICATION OF CRITICAL EXPERIMENT FUEL ELEMENTS—TASK 7323. John L. Swanson and Frank H. Welch (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Aug. 17, 1956. Contract AT(11-1)-171. 25p.

The early development work and the results of the production run using enriched U_3O_8 are summarized. The results of the sampling procedure for determination of SS factor weight, and the SS Accountability balance for the production are presented, and the results of the tensile strength and bending angle test on irradiated and control modified fuel elements are summarized. (auth)

7241 (DC-58-9-151) DYNAMIC TEST OF UNCLAD SLOTTED MODERATOR (PROJECT 102 NO. 5YN007X3 T-1). P. E. Reis and B. A. Chandler (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Sept. 19, 1958. Contract AT(11-1)-171. 24p.

A full-size unclad zirconium hydride moderator (18 cooling slots) was tested for dimensional stability, structural integrity and H loss, and migration. The test piece was run for 30 cycles with each cycle consisting of a heating period of 20 minutes, a dwell period at a maximum temperature of 1150°F for 3 hours, and a cooling period (to 300°F) which required 8 minutes. At the completion of the thermal cycling numerous circumferential cracks from ¼ to ½ in. long were found on the inside diameter about 8 to 10 in. from the exit end. No cracks developed on the outer surface. A longitudinal growth of 194 mils occurred. The inside diameter increased by 93 mils and the diametral thickness was reduced by 38 mils resulting from longitudinal and circumferential growth. (auth)

7242 NEW METHODS FOR THE CALCULATION OF BURNUP IN REACTORS. E. Kern (Brown Boveri Krupp Reaktorbau GmbH, Mannheim, Ger.). Atomkernenergie, 6: 397-408(Oct. 1961). (In German)

A general formulation of loading calculations and their transformation to a system of partial differential equations are shown. A generalization is made for loading in transiently changing power. The neglect of burn-up dependence on radius is considered. Solution methods with an analog computer are given, and examples are presented. (J.S.R.)

7243 THE DETERMINATION OF BURN-UP IN SPENT FUEL ELEMENTS. A. P. Smirnov-Averin, V. I. Galkov, I. G. Sheinker, V. P. Meshcheryakov, L. A. Stabenova, and B. S. Kir'yanov. Atomnaya Energ., 11: 454-6(Nov. 1961). (In Russian)

A simple method of determining the burn-up of U^{235} depends on the determination of long-lived Cs^{137} by scintillation counting. Corrections for the Cs^{134} content can be made by counting the β- γ-coincidences which are due only to the Cs^{134} activity content. The burn-up at various points of a spent fuel rod was obtained by determining the Cs^{137} content. The results agreed within 10% with the mass-spectrometric determinations of the U^{235} content. The content of Tc^{99} ($T_{½} = 2.2 \times 10^5$ years) was also determined by multiple extraction with methylethylketone and final purification on a cation exchange. The Tc^{99} was counted on a 4 π-counter. The burnup determined from the Tc^{99} content was found to be 67%. A Cs^{137} determination on the same sample gave a burnup of 68%, while the mass-spectroscopic

value for the same sample was 66.2%. As is evident, the agreement between the various methods is good. (TTT)

7244 ORGANIC MATERIALS AS REACTOR MODERATORS. István Kiss, István Kósa-Somogyi, and Elekné Sazbó (Central Physical Research Inst., Szeged). Energia és Atomtech., 14: 454-62(Oct. 1961). (In Hungarian)

Hydrocarbons with a high boiling point represent a suitable compromise of physical and chemical properties for use as moderators and possibly simultaneously as coolants in nuclear reactors. Use of diphenyl for such a purpose was recommended as early as 1944 by Fermi and Szilard. Terphenyls and other polyphenyls are under investigation at present. In spite of several reactor projects involving the use of organic moderators, such as the OMRE and the Piqua reactors in the U. S. and others in West Germany, Holland, Italy, Spain, the Soviet Union and Mexico the problem is still far from being solved. The unsaturated hydrocarbons proposed for this purpose present the advantage of high boiling point and corresponding low vapor pressure and lack of corrosive properties with respect to most structural materials but they are subject to a certain amount of radiolysis, chemical decomposition and polymerization with subsequent increase of their viscosity and decrease of their heat capacity and thermal conductivity. It is assumed that materials are useable as a moderator and/or coolant as long as the polymerization products do not exceed 30%. The radiochemical behavior of the proposed organics and their deuterium-substitutes is discussed on the basis of the published literature. (147 references). (TTT)

7245 ORGANIC MODERATORS. Ph. Traynard and G. de Gaudemaris (Institut Français du Pétrole, [Paris]). Énergie nucléaire, 3: 298-308(Sept.-Oct. 1961). (In French)

After a review of the studies made on the thermal and radiolytic stability of organic compounds, the OMRE Reactor in Idaho is described. The advantages of this reactor (simplicity of construction), the disadvantages (unfavorable thermal transfer and moderator radiolysis), and the solutions are discussed in detail for terphenyl. Studies being made on the use of other liquids are reviewed. (J.S.R.)

7246 THE UTILIZATION OF ORGANIC COMPOUNDS AS MODERATORS AND COOLANTS IN NUCLEAR REACTORS. SUMMARY REPORT. M. Starke (Institut für Angewandte Physik der Reinststoffe, Dresden). Kernenergie, 4: 669-84(Sept. 1961). (In German)

In the last few years investigations made on organic compounds have established the suitability of polyphenyls as reactor moderators and coolants. The introduction of these materials necessitates an accurate knowledge of the behavior of organic compounds under irradiation. The present report gives a survey on the principal results of works published up to the present. The topics discussed are the necessary characteristics of moderators and coolants, organic substances studied and used, measurement of products formed by heat and radiation effects, dependence on the type of radiation, pyrolysis, radiolysis, mixtures of different polyphenyls, and some operational data from organic cooled and moderated reactors. 116 references. (J.S.R.)

7247 GENERAL PROPERTIES OF THE RESPONSE OF A NUCLEAR REACTOR AT LOW POWER UNDERGOING A PERIODIC REACTIVITY VARIATION. Henri B. Smets (European Nuclear Energy Agency, Paris). Nukleonik, 3: 181-5(Oct. 1961). (In English)

Various general properties of the response of a nuclear reactor to a periodic variation of reactivity are proved. In particular the response is periodic with the same period as the reactivity only when the average value of the reactivity is negative, and is unstable when the average value of the reactivity is zero. (auth)

7248 NUCLEAR BASES FOR THE LOCATION AND STRUCTURE SELECTION OF NUCLEAR REACTORS. [PART II]. G. Blaesser and K. Wirtz (Kernforschungszentrums, Karlsruhe, Ger.). Nukleonik, 3: 210-31(Oct. 1961). (In German)

The dissemination and effects of radioactive clouds and the statistical treatment of safety problems are discussed. Examples using homogeneous aqueous reactors, heavy-water natural-uranium reactors, and quasi-homogeneous reactor are given. (J.S.R.)

7249 NON-STATIONARY HEAT TRANSFER PROBLEM IN GAS-COOLED HETEROGENEOUS REACTOR. Paul Drossbach (Technische Hochschule, Munich). Nukleonik, 3: 313-18(Dec. 1961). (In German)

Heat transfer dependence on neutron flux is discussed. Methods of calculating heat transfer for a uranium full cylinder gas cooled around the edge, a graphite ring cooled at the inner edge, and a uranium ring with inner and outer cooling are given. An example is presented of a heterogeneous reactor with CO_2 as coolant in the gap between the uranium rod and graphite moderator. (M.C.G.)

7250 RECENT IMPROVEMENTS IN SAFETY AMPLIFIER SYSTEMS. Roger S. Dreffin (AMF Atomics, Inc., New York). Research Reactor J., 1: No. 2, 13-14; 17(Jan. 1961).

A discussion is given of seven problem areas in safety amplifier systems and improvements made to the systems. The areas discussed are: false scrams, shift in apparent power level, reduction of high voltage on coaxial cables, magnet current indication, high flux reverse relay, scram test circuit, and magnet current relays. Improved circuits are shown for regulated power supply, sensitivity control, cable monitor, and scram test. (N.W.R.)

7251 INDUSTRIAL APPLICATIONS OF NUCLEAR ENERGY. 3rd INTER-AMERICAN SYMPOSIUM ON THE PEACEFUL APPLICATION OF NUCLEAR ENERGY, RIO DE JANEIRO, 1960. (Inter-American Nuclear Energy Commission, Washington, D. C. and Brazil. Comissão Nacional de Energía Nuclear). 1961. 380p. $2.50(IANEC).

The papers delivered at the Third Inter-American Symposium on the Peaceful Application of Nuclear Energy are presented in the original language. Abstracts of each paper are given in English, Portuguese, and Spanish. Separate abstracts are given in NSA for 29 of the papers. Three were previously abstracted for NSA. (M.C.G.)

7252 SPECTRUM MEASUREMENT OF THE RA-1 BY THE INTEGRAL METHOD. Guillermo Ricabarra and María Delfina Bovisio de Ricabarra (Comisión Nacional de Energía Atomica, Buenos Aires). p.15-25 of "Industrial Applications of Nuclear Energy." Washington, D. C., Inter-American Nuclear Energy Commission, 1961. (In Spanish)

A sensitive and fast system to determine the spectrum of a reactor was employed, basically by utilizing Al and Mn as detectors. The theory of activation of a foil in a neutron field and the factors to be used are discussed and some errors in the experimental results are noted. The measurement of the epithermal spectrum by activation of pairs of detectors is explained. Primarily, the use of In and Mn is discussed. Aluminum was used to measure fast flux, and its suitability, in comparison with that of the other threshold detectors, is discussed. Finally the neutron spectrum of the RA-1 was measured. The distribution curves were plotted and the results are given. (auth)

7253 THEORY OF PERTURBATION–APPLICATION TO THE AXIAL FLUX DISTRIBUTION IN A 50 MWE-BWR. Bernardino Pontes (Comisión Nacional de Energía Atomica, Buenos Aires). p.27-36 of "Industrial Applications of Nuclear Energy." Washington, D. C., Inter-American Nuclear Energy Commission, 1961. (In Portuguese)

When physics calculations were made in 1958 of a boiling water reactor for a power plant because of lack of time it was not possible to consider a number of details and refinements of the project. In the determination of the axial flux, for example, the calculations were started from the assumption of a homogeneous distribution of voids in the reactor, which produced a result that was not very accurate. Therefore an attempt was made to calculate a new flux distribution by a more accurate method. The method of subdividing the reactor into horizontal layers or zones and considering a homogeneous distribution of voids for each of them, according to the total amount of voids in each zone, could be used. However the perturbation theory was adopted for this calculation. (auth)

7254 PRODUCTION OF NUCLEARLY PURE URANIUM. STUDY ON THE DECONTAMINATION OF URANIUM FROM THORIUM AND RARE EARTHS BY EXTRACTION WITH TRIBUTYLPHOSPHATE. K. J. Bril and P. Krumholz (Laboratório de Pesquisas da Orquima, S/A, São Paulo, Brazil). p.37-59 of "Industrial Applications of Nuclear Energy." Washington, D. C., Inter-American Nuclear Energy Commission, 1961. (In Portugese)

Conditions are reported that determine the degree of decontamination of uranium from accompanying impurities, in particular from thorium and from the rare earths in a process based on the extraction of uranyl nitrate with tributylphosphate. The coefficient of distribution of various compounds that are likely to be impurities in uranium concentrates was determined for conditions ranging from an aqueous phase (containing 1M amonium nitrate and 0.5M nitric acid as extraction aids) and an organic phase (35% by volume tributylphosphate and 65% by volume varsol). The coefficients of distribution of uranyl, thorium, and europium nitrates were determined as a function of the concentration of uranyl nitrate or of free tributylphosphate. The experimental values of these coefficients were used to calculate the distribution of uranium, thorium, and europium in the two phases of an extractive system having several stages; the results were analyzed to determine the best conditions for the most complete extraction and uranium decontamination. Thorium reflux was studied, particularly the elimination of this reflux by the addition of sulfate ions as complexing agents. A similar analysis of the organic phase in several stages was made with regard to a scrubbing system. The conclusion was that in conditions of near saturation of the organic solvent with uranyl nitrate, four stages of extraction and three of scrubbing (with 10% by volume of a 1 M solution of amonium nitrate) are necessary for the extraction of 99.9% of the uranium which will meet specifications for nuclear purity. The theoretical results are compared and confirmed by experiments on extraction of uranium with tributylphosphate-varsol and subsequent scrubbing of the organic phase made in a decanting-mixing unit. Factors of decontamination of uranium–thorium higher than 10^4 were obtained in a system of four stages of extraction and two stages of scrubbing. The results obtained permit a rational analysis of the industrial process of uranium purification by extraction with tributylphosphate and suggest certain improvements. (auth)

7255 RECYCLE OF REACTOR FUELS. S. Lawroski (Argonne National Lab., Ill.). p.61-75 of "Industrial Applications of Nuclear Energy." Washington, D. C., Inter-American Nuclear Energy Commission, 1961. (In English)

One of the major chemical engineering problems in the industrial application of nuclear energy is the recycle of reactor fuels. Included in fuel recycle operations are: chemical reprocessing for the recovery and purification of fissile and fertile materials; treatment and storage of radioactive waste products; and refabrication of recovered fuel. At the present time solvent extraction methods with organic solvents are almost universally employed to perform the chemical reprocessing step on uranium, plutonium or thorium fuels obtained from research, test or power reactors. In addition to their versatility for handling widely different fuels, solvent extraction processes are adaptable to small, intermediate, and large scale applications and, in most instances, do not impose especially difficult problems as regards design, equipment, or materials. In view of the current and probable long-range role of these processes, a discussion is given of their chemical and engineering features. The technical and economic advantages and disadvantages of these processes are also discussed. Insofar as possible and from a similar standpoint, newer processing methods, such as the fluoride volatility and pyrometallurgical processes are described and evaluated in terms of their short and long-range potential. The effects of reprocessing methods on other parts of the fuel cycle are discussed. One important effect results from the differences between the principal forms of radioactive waste products obtained from solvent extraction, fluoride volatility, and pyrometallurgical types of processes. The influence of these differences on waste treatment and storage is described. Finally, some aspects of the fabrication portion of the fuel recycle are discussed. Emphasis is placed on new developments in remote fuel fabrication. This situation is encountered when the recovered fuel is radioactive because of incomplete removal of fission products such as is the case with the use of pyrometallurgical processes for fast breeder reactors. These processes offer economic advantages for the special problems of fuel recycle in fast reactors. Therefore, intensive development of a fuel cycle embodying pyrometallurgical processes and remote fuel fabrication is in progress in connection with the Experimental Breeder Reactor-II. The status of this development is presented. (auth)

7256 PRODUCTION OF CARRIER-FREE PHOSPHORUS-32 BY USING SULPHATES AS MATERIAL FOR IRRADIATION. Alcídio Abrão, Fausto W. Lima, and Laura Tognoli (Instituto de Energia Atômica, São Paulo, Brazil). p.77-80 of "Industrial Applications of Nuclear Energy." Washington, D. C., Inter-American Nuclear Energy Commission, 1961. (In English)

The method for producing P^{32} by using material for irradiation other than elemental sulfur is discussed. The set of chemical operations, apparatus, yields, and advantages are described. (auth)

7257 THE PROSPECTS FOR BREEDING IN THE LIGHT OF RECENT REACTOR PHYSICS DATA. Clarke Williams (Brookhaven National Lab., Upton, N. Y.). p.81-7 of "Industrial Applications of Nuclear Energy." Washington, D. C., Inter-American Nuclear Energy Commission, 1961. (BNL-4813). (In English)

The most recent estimates of the value of Eta for U^{233} and the influence of this and other nuclear data on the prospects for thermal breeding are reviewed. The effects of various core materials and the build-up of higher isotopes and fission products are included. The way in which these data may be expected to affect the performance of

some of the more recent breeding reactor concepts is considered. (auth)

7258 The U^{233}–THORIUM CYCLE IN ONE REGION THERMAL REACTORS. A PARAMETRIC DISCUSSION. Sergio de Salvo Brito (Comissão Nacional de Energia Nuclear, Rio de Janeiro). p.89-107 of "Industrial Applications of Nuclear Energy." Washington, D. C., Inter-American Nuclear Energy Commission, 1961. (In Portuguese)

The possibility of obtaining doubling times of fuel that would justify the utilization of the U^{233}–thorium cycle as the basis of a national program of electric power from nuclear sources, using single-region heterogeneous thermal power reactors fueled with rods of thorium that were previously irradiated to an optimum U^{233} concentration was analyzed. Assuming for greater simplicity a constant thermal neutron flux spatially uniform throughout the core, the differential equations representing time variation of the concentration of Th, U^{233}, and Pa^{233} in the fuel element were developed and integrated for several values of initial enrichment and of flux. In each case a minimum value of flux was determined, below which it is impossible to obtain an advantageous fuel production rate. When increasing fluxes were considered, the tendency of Pa^{233} to accumulate in the fuel rods was observed. This tendency is due to the long half-life of Pa^{233}, and it can reach a state that will cause complete poisoning of the reactor. Analysis of these results showed that, in general, breeder reactors of this type must have high power output, high flux, and large dimensions. Furthermore, they must have good neutron economy. Even so, in most cases, too short a useful life can be expected, as a result of the decline in the amount of fuel, with practically no regeneration, because of the phase difference introduced by the disintegration of Pa^{233}. Various programs for operation of the reactor are discussed, with a view to overcoming this difficulty. After two possible solutions, based on the use respectively of removable poisons and of additional rods of highly enriched fuel, were proposed, discussed, and abandoned, the viability of a third solution was demonstrated. It consists in maintaining the reactivity of the reactor constant, by varying the number of fuel rods in the core. Taking into account the variations in reactivity due to changes in the concentrations of U^{233}, thorium, and Pa^{233}, and the increase in fission products, the rates of production of U^{233} were calculated for various values of initial enrichment and flux. In this way, in a graph of flux vs enrichment, a definite region is determined within which any project must fall if it is to obtain adequate duplication-time values. Some problems of engineering and control inherent in this concept of the reactor are briefly considered, and certain illustrative parameters are discussed, such as the influence of variations in flux during operation, useful life with production of U^{233}, the relative number of additional rods that must be moved inside the reactor, and the optimum critical mass and power level for it. (auth)

7259 CONSTRUCTION OF A 0.5 Mev VAN DE GRAAFF ACCELERATOR FOR RESEARCH AND TEACHING USE. Armando C. López (Universidad, Guanajuato, Mexico). p.109-13 of "Industrial Applications of Nuclear Energy." Washington, D. C., Inter-American Nuclear Energy Commission, 1961. (In Spanish)

A 500,000 ev Van de Graaff electrostatic accelerator, at atmospheric pressure, was designed and is being constructed. It will be used for accelerating electrons. In addition to the use of this machine for laboratory teaching of basic concepts of atomic physics, it will also be used for research. The experimental program proposed for this laboratory includes such topics as these: luminescence of crystals under electron bombardment at different temperatures; structural modifications of copolymers by fast electrons; continued study of biochemical effects of x rays and electrons, in connection with cancer studies, and x-ray analysis of materials. (auth)

7260 ISOTOPES. W. F. Libby (Univ. of California, Los Angeles). p.115-20 of "Industrial Applications of Nuclear Energy." Washington, D. C., Inter-American Nuclear Energy Commission, 1961. (In English)

The continuing growth of isotope applications in the United States is described and a prediction of future growth made. Specific applications are treated to show the isotope technique as an integral part of the industrial scene in the United States. Applications in agriculture, medicine, and industry are among those discussed. (M.C.G.)

7261 POSSIBILITIES OF PRODUCTION OF ISOTOPES WITH A MEDIUM-FLUX REACTOR. Juan Flegenheimer (Comisión Nacional de Energía Atómica, Buenos Aires). p.121-4 of "Industrial Applications of Nuclear Energy." Washington, D. C., Inter-American Nuclear Energy Commission, 1961. (In Spanish)

Possibilities for the production of isotopes using a medium-flux reactor were analyzed with reference to the capacity of the recently modified Argentine RA-1 reactor. Radiochemical experience obtained with this reactor up to the present time is described, and its limitation with respect to the future isotope needs of Argentina is described. Based on some examples of isotope production (Br^{82}, Na^{24}, Au^{198}, etc.) the requirements for the separation and fractionation laboratories are outlined. (auth)

7262 USE OF RADIOISOTOPES IN THE PETROLEUM INDUSTRY. Mentech Colonomos Pardo (Instituto Venezolano de Investigaciones Científicas, Caracas). p.125-9 of "Industrial Applications of Nuclear Energy." Washington, D. C., Inter-American Nuclear Energy Commission, 1961. (In Spanish)

The methods employed in petroleum exploitation using radioactive isotopes and neutron sources, among them gamma-ray and neutron profile-sketching, are described with particular reference to cementation of wells and radioactive tracers. Also mentioned are the various types of isotopes used in the Venezuelan petroleum industry, and their origins, as well as the contribution of IVIC to the future development of peaceful applications of nuclear energy. (auth)

7263 FUEL ELEMENT TECHNOLOGY. (Works in Progress in Argentina). p.131-9 of "Industrial Applications of Nuclear Energy." Washington, D. C., Inter-American Nuclear Energy Commission, 1961. (In Spanish)

In nuclear reactor fuel element technology, the Metallurgy Division of the National Atomic Energy Commission of Argentina is carrying out several projects. The development and manufacture of fuel elements for the new core of the experimental reactor RA-1 are described. These fuel elements have a cylindrical form (10 mm diameter and 400 mm effective length), and consist of U_3O_8 dispersed in aluminum and are clad with aluminum. The elements are extruded. Development of a sintered UO_2 fuel element prototype clad with aluminum, using lead as bonding agent, for low enrichment boiling water reactors is discussed. A natural metallic uranium fuel element prototype clad with aluminum is being developed. The uranium rods are fully clad in aluminum tubes by a process of "trefilation", which is carried out in such a manner as to result in predeter-

mined radial residual stresses which later will produce close contact between the uranium core and the aluminum cladding. Corrosion of aluminum alloys in high temperature water is being studied in order to develop an alloy with low chrome or nickel content that could be used as cladding material in a reactor of natural metallic uranium or of sintered uranium oxide having low enrichment and using high temperature water. The most appropriate thermal processes for the metallic uranium rods that act as the core of the fuel element previously described are being developed. (auth)

7264 OBJECTIVES OF U. S. RESEARCH ON NUCLEAR FUELS FOR CIVILIAN POWER REACTORS. R. W. Dayton (Battelle Memorial Inst., Columbus, Ohio). p.141-61 of "Industrial Applications of Nuclear Energy." Washington, D. C., Inter-American Nuclear Energy Commission, 1961. (In English)

The major objective of U. S. research on nuclear fuels is cost reduction, by achieving higher specific power, longer burnup, decreased parasitic neutron capture, and lower reprocessing costs. The progress being made in these directions is described for fuel elements made from the major fuel materials, which are: low alloy uranium, uranium-10 wt % molybdenum, uranium dioxide, uranium carbide, and graphite containing dispersed uranium compounds. The most important problems of each fuel material are emphasized. The problems of fabricating fuel elements more cheaply from these materials are also discussed. Research on thorium and plutonium containing materials is not in as advanced a state as that on the uranium containing materials. The present status of research on such materials is for that reason discussed only briefly. (auth)

7265 A NEW METHOD FOR THE INDIVIDUAL DETECTION OF FAILED FUEL ELEMENTS IN SWIMMING POOL REACTORS. P. Saraiva de Toledo, M. D. de Souza Santos, R. Brenner, and A. C. Penteado (Instituto de Energia Atômica, São Paulo, Brazil). p.163-6 of "Industrial Applications of Nuclear Energy." Washington, D. C., Inter-American Nuclear Energy Commission, 1961. (In English)

A method is presented that permits the individual detection of failed fuel elements, of the MTR-type used in swimming-pool reactors. Essentially the method consists in putting the fuel element under test in a position near the core of the reactor, operating at a power level of 10 kw. Some gaseous fission products eventually released from the fuel element are carried out by an air stream that is forced to circulate through the plates of the fuel element and absorbed in active carbon. The activity of this active carbon filter is then measured by a scintillating counter and, by comparison, it is possible to determine if an individual fuel element has failed. The apparatus used is of simple construction and it is possible to test a fuel element in about half an hour. (auth)

7266 HAZARD REPORT ON THE TRIGA REACTOR TO BE INSTALLED AT BELO HORIZONTE, BRAZIL. B. Cimbleris, C. M. Mascarenhas Dale, C. W. Urban, and C. R. Pereira (Universidade, Minas Gerais, Brazil). p.175-205 of "Industrial Applications of Nuclear Energy." Washington, D. C., Inter-American Nuclear Energy Commission, 1961. (In Portuguese)

The possible normal and abnormal operation conditions of the TRIGA reactor to be installed at Belo Horizonte were analyzed and it was concluded that in no situation would it represent a potential danger to the operating personnel or the population in general. In the analysis the following ambiental factors were taken into consideration: location; the local geology, hydrology, seismology and climatology; the population density and distribution; the reactor building and lot and its surroundings. In the evaluation of the safety of this reactor its dynamic characteristics were taken into account, as well as the effect of conceivable natural or provoked catastrophes. (auth)

7267 THE MANAGEMENT OF RADIOACTIVE WASTES FROM NUCLEAR ENERGY OPERATIONS. Joseph A. Lieberman (U. S. Atomic Energy Commission, Washington, D. C.). p.207-17 of "Industrial Applications of Nuclear Energy." Washington, D. C., Inter-American Nuclear Energy Commission, 1961. (In English)

The technical and administrative aspects of radioactive waste management are discussed in the light of existing experience and knowledge and to relate such discussion to possible future requirements for the adequate engineering, public health, and administrative control of radioactive effluents from various nuclear energy activities. The variety of radioactive wastes is categorized in a general way on the basis of their hazard potential to emphasize that the problem of radioactive waste management has numerous facets and is not amenable to a single, universal solution. The role of specific environments in waste disposal practices is summarized and the basic approaches ("dilute and disperse" and "concentrate and contain") to effluent control are defined. Distinction is made between basic radiation protection standards or guides, and operating or performance criteria that must be established in connection with effluent control operations in order to assure the protection of public health and safety. Examples of radioactive waste disposal practice and experience in the United States, for different types of wastes, are described and tentative conclusions are drawn regarding the capabilities and limitations of these practices. The scope and objectives of the research and development program in this field are summarized. The status of work in major waste disposal development projects is noted. Development of guides and criteria and their application in establishment of health and safety regulations and other pertinent administrative procedures is discussed. The utilization, to the maximum practicable extent, of existing laws and administrative procedures in existing agencies at various levels of government is suggested as being advantageous from an administrative and public relations standpoint. Economic factors related to handling and disposal of radioactive wastes are noted, including relation of nuclear plant location to disposal requirements. It is pointed out that, although total costs for treatment and disposal are substantial, the cost per unit of electrical energy produced is a rather small percentage of the total cost per unit of energy. (auth)

7268 SOME INDUSTRIAL APPLICATIONS OF THE TRIGA REACTOR OF THE INSTITUTE OF RADIOACTIVE RESEARCH, SCHOOL OF ENGINEERING, UNIVERSITY OF MINAS GERAIS. Francisco de Assis Magalhães Gomes (Universidade, Minas Gerais, Brazil). p.227-30 of "Industrial Applications of Nuclear Energy." Washington, D. C., Inter-American Nuclear Energy Commission, 1961. (In Portuguese)

An evaluation was made of the possibility of using the experimental reactor TRIGA that is being installed at the Institute of Radioactive Research, School of Engineering, University of Minas Gerais, to give assistance to industry. This program particularly emphasizes the possibility of the use of radioisotopes produced in this reactor for process studies in connection with industries of local interest,

such as metallurgy, textile manufacturing, cement, etc. (auth)

7269 DETERMINATION OF INTERCONNECTIONS IN GAS-PIPELINE SYSTEMS. J. Pahissa-Campá, E. Alvarez, C. A. Henkel, L. J. Anghileri, and O. O. Gatti (Comisión Nacional de Energía Atomica, Buenos Aires). p.231-3 of "Industrial Applications of Nuclear Energy." Washington, D. C., Inter-American Nuclear Energy Commission, 1961. (In Spanish)

The problem of determining the path of gases in a pipeline distribution system was solved by employing a radioactive material as tracer. Specifications for the radioactive tracer were as follows: gaseous at normal temperatures; similarity with natural components of the gas; non-reactivity with the pipeline materials; low solubility in water; short half-life, within the limits of the requirements for conducting the experiment; and easily detected radiation. For this particular application Br^{82} labelled methyl bromide possessed the required conditions. The detection method used was fixation of the bromide in paper drenched in a hydroalcoholic solution of silver nitrate, followed by Geiger-Müller counting. The method employed to obtain labelled methyl bromide is explained. (auth)

7270 EQUIPMENT FOR INDUSTRIAL GAMMA-RADIOGRAPHY BUILT IN ARGENTINA. A. Capo, N. Mundiroff, and C. Papadópulos (Comisión Nacional de Energía Buenos Aires). p.235-9 of "Industrial Applications of Nuclear Energy." Washington, D. C., Inter-American Nuclear Energy Commission, 1961. (In Spanish)

The main characteristics of the gamma-radiography equipment built in Argentina by the National Atomic Energy Commission and by private industry are described. The equipment was classified according to its application. (auth)

7271 UTILIZATION OF NUCLEAR ELECTRIC POWER IN THE NORTHERN ZONE OF CHILE. E. Friedmann M. (Empresa Nacional de Electricidad, S. A., Chile). p.249-61 of "Industrial Applications of Nuclear Energy." Washington, D. C., Inter-American Nuclear Energy Commission, 1961. (In Spanish)

In the Central and Southern Zones of Chile, it is very doubtful that economical application of nuclear power can be achieved, in view of the abundant hydroelectric resources capable of providing power at low cost. In the Northern Zone, however, its use proves attractive because of important consumption with a high load factor, the lack of hydroelectric resources, and the high cost of power derived from coal and from oil. Costs are compared for conventional thermal plants and for nuclear plants, with a net power of 50 MWe, that would serve the system made up of the plants of Anaconda Copper Co. (145 MW), Anglo Lautaro Nitrate Co. (50 MW), and ENDESA, the public power enterprise that provides electricity to the neighboring cities. This system is not completely interconnected, but this could be done at a moderate cost. The comparison favors the nuclear plant first, an oil plant second, and leaves coal as the energy source in third place. (auth)

7272 PRINCIPLES OF THE DESIGN OF THE RAEP REACTOR. J. Cosentino, J. Gosztonyi, C. Mayans, and E. Nasjleti (Comisión Nactional de Energía Atómica, Buenos Aires). p.263-8 of "Industrial Applications of Nuclear Energy." Washington, D. C., Inter-American Nuclear Energy Commission, 1961. (In Spanish)

The general principles utilized to draft the preliminary design of a 3 to 5 MW research and radioisotope production reactor are described. (auth)

7273 PRESENT STATUS AND FUTURE PROSPECTS OF THE PRESSURIZED LIGHT WATER NUCLEAR REACTOR. A. R. Jones (Westinghouse Electric Corp., Pittsburgh). p.269-78 of "Industrial Applications of Nuclear Energy." Washington, D. C., Inter-American Nuclear Energy Commission, 1961. (In English)

The history of pressurized water reactors is discussed in light of reactors already operating and those in the construction and planning stages. Potential is explored and examples of development programs currently underway to realize these potentials are cited. Features contributing to the success and wide acceptance of pressurized water reactors are presented. The present status is discussed in terms of design and economics. (auth)

7274 PROSPECTS FOR ECONOMIC POWER FROM BOILING WATER REACTORS. W. N. Oberly and H. C. Anderson (General Electric Co., San Jose, Calif.). p.287-93 of "Industrial Applications of Nuclear Energy." Washington D. C., Inter-American Nuclear Energy Commission, 1961. (In English)

The objectives to be accomplished in the advancement of boiling water reactors in connection with utility operation are discussed. The current status of boiling water reactors is reviewed, starting with the experience of the United States Atomic Energy Commission with the BORAX and SPERT experiments up to the current operation of Dresden. The technical development program being followed by General Electric in the United States is described. The program objectives and the phases of each step are discussed. The goals of each phase and the comparison of power cost expected at each stage are developed. The projected power cost in the United States, including a breakdown into the capital cost and power cost, is presented for the plants scheduled for operation in each phase. The expected reductions in capital cost and fuel cost are discussed, comparing present day nuclear power costs, considered as first generation phase, with those of the plants in each succeeding phase. The evolution of a representative series of plants as it progresses through each of the four phases of the program is described. The effect of each technological improvement on the achievement of power cost reduction is discussed. (auth)

7275 PRESENT STATUS AND FUTURE POTENTIAL OF ORGANIC COOLED NUCLEAR POWER PLANTS. Sidney Siegel (Atomics International, Canoga Park, Calif.). p.295-308 of "Industrial Applications of Nuclear Energy." Washington, D. C., Inter-American Nuclear Energy Commission, 1961. (In English)

Reactors cooled by organic, hydrocarbon fluids have particular merit for central station power, marine propulsion, and process heat applications. Principal development effort was devoted to coolant technology. The polyphenyls, terphenyls typically, provide an optimum combination of properties; moderate melting temperature (60°C), low vapor pressure (2 bars) at operating temperatures near 425°C, and good thermal and radiation stability ($G_p = 0.07$). Extensive convective and boiling heat transfer tests were conducted; at coolant velocities of 5m/sec, h = 0.6 watts/cm^2°C. Deposits were observed on heat transfer surfaces, but can be prevented by maintaining the coolant free of inorganic particulate impurities. Column distillation satisfactorily controls the coolant high boiler concentration. The non-corrosive nature of organic fluids permits a wide choice of core materials. Organics are compatible with aluminum, low carbon steel, stainless steel, and all metal alloy and ceramic fuel materials. Uranium dioxide pellets contained in finned aluminum alloy tubes, and uranium–

molybdenum alloy plates or tubes clad with extended surface extrusions, are two preferred fuel element types, capable of operation at 450°C surface temperature and peak exposures up to 20,000 MWD/MTU. Organic reactors for central station electric generation were extensively investigated. An 11-kW prototype is nearing completion in Piqua, Ohio. Investigation of the use of different moderators with organic coolant showed attractive possibilities for a graphite moderated tubed reactor producing superheated steam at 59 bars, 472°C. With D_2O moderation, natural uranium fuel may be used. A 300 MW(e) organic cooled and moderated plant employing nucleate boiling heat transfer and 450°C surface temperature aluminum alloy clad oxide fuel can produce energy for 7.3 mills/kWh. Future fuels capable of larger burnup and higher operating temperature appear probable. Cheaper, alternate fluids are being explored. The modest heat transfer of all organic fluids may be augmented by turbulence promoters, boiling, or higher permissible temperature drive. Estimates for plants incorporating such improvements yield power costs of 5.9 mills/kWh. Work on these problems is in progress at the OMRE, and in the near future in the Experimental Organic Cooled Reactor which is presently being designed. (auth)

7276 GAS-COOLED REACTORS AND THERMAL BREEDERS. W. H. Jordan (Oak Ridge National Lab., Tenn.). p.310-18 of "Industrial Applications of Nuclear Energy." Washington, D. C., Inter-American Nuclear Energy Commission, 1961. (In English)

An Experimental Gas-Cooled Reactor (EGCR) is under construction in Oak Ridge, Tennessee. Plant characteristics and layout are briefly described and the major design considerations discussed. The choice of helium as a coolant was made in order to achieve a high outlet temperature (1050°F) and to avoid problems of chemical reactions with the graphite moderator. The reactor will generate 25 Mw of electricity with a net efficiency of 28%. Although the costs of the power generated by the EGCR will be relatively high because of its small size and experimental nature, a scaled-up version could produce electricity for approximately 10 mills/kwh. There are several paths of development of gas-cooled reactors which could lead to significant reduction in power cost. The use of beryllium-clad fuel elements or graphite-clad fuel elements would greatly improve the neutron economy, thus permitting higher burnup and lower fuel costs. Much higher temperature could be achieved with graphite-clad fuel elements, however the coolant gas would become contaminated with fission products which complicate the design of the system. The status of the advanced gas-cooled reactor technology is summarized. A study was made of the breeding capabilities of several thermal reactors which utilize the U^{233}–Th cycle. The aqueous homogeneous, molten salt, and liquid bismuth breeder reactors have potential doubling times under 25 years. The status of the experimental aqueous-homogeneous and molten-salt reactors at Oak Ridge is presented. (auth)

7277 THE NUCLEAR SHIP SAVANNAH. W. T. Moore (Babcock & Wilcox Co., New York). p.319-29 of "Industrial Applications of Nuclear Energy." Washington, D. C., Inter-American Nuclear Energy Commission, 1961. (In English)

The Savannah is a single-screw, all steel, 9-compartment passenger-cargo ship of the "Mariner" type. The ship is 596 ft long over-all and 78 ft wide, with a full load displacement of 21,800 long tons; a sea speed of 20 knots, and a cruising radius in excess of 100,000 miles. She is equipped to carry 60 passengers plus cargo. The nuclear power plant is of the pressurized water type utilizing slightly enriched uranium oxide as fuel (4.4 average weight percent U^{235}). The primary system and auxiliary piping which contain high pressure, high temperature primary water are located inside a cylindrical containment vessel 50 ft long and 35 ft diameter. The major parameters of the nuclear system are listed and photographs are shown of reactor pressure vessel and boilers being installed in the ship. The core is described with illustrations of fuel elements and control rods. Critical and hot exponential experiments are discussed with photographs of the critical experiment and of the actual core and control rods assembled after manufacture for zero power experiments, which confirmed calculations and the accuracy of the manufacturing process. The reactor is well shielded, and a health and safety staff will continuously monitor all occupied areas to make sure that the radiation dose rates do not exceed acceptable levels. The prompt negative fuel temperature coefficient associated with the Doppler broadening of the uranium-238 absorption resonances, coupled with the self-controlling features of water moderated reactors, results in a high degree of inherent stability and safety in reactor operation. Although the Savannah is not intended to be economically competitive, her construction and operation will provide a base of practical experience. (auth)

7278 VENEZUELAN REACTOR NO. 1. Gustavo Rada A. (Instituto Venezolano de Investigaciones Científicas, Caracas). p.331-40 of "Industrial Applications of Nuclear Energy." Washington, D. C., Inter-American Nuclear Energy Commission, 1961. (In Spanish)

Features of the Venezuelan Research Reactor No. 1 (RV-1), the progress achieved to date toward its installation, and the planned programs for its evaluation are described. (auth)

7279 THE PUERTO RICO WATER RESOURCES AUTHORITY CONSTRUCTS A NUCLEAR POWER PLANT. S. L. Descartes and Victor M. Cataldo (Puerto Rico Water Resources Authority, San Juan). p.341-9 of "Industrial Applications of Nuclear Energy." Washington, D. C., Inter-American Nuclear Energy Commission, 1961. (In English)

The Puerto Rico Water Resources Authority entered the nuclear field in 1955 and is designing and building a nuclear power plant which will be in operation late in 1962. In June, 1958 the Authority presented a proposal to the Atomic Energy Commission to develop an advanced type of power reactor. It is a boiling water reactor with nuclear superheater. The feasibility study was successful and the Authority signed a contract for the design, construction and operation of a 16,300 kilowatt nuclear plant to be installed in Puerto Rico. Under the terms of the contract the Authority provides the land, site improvements, and utility services. It also provides the conventional components of the nuclear plant consisting of the turbine-generator, condenser, cooling water system, electrical switchgear, outdoor switchyard, and associated equipment. The Atomic Energy Commission will design and construct the nuclear reactor and all nuclear components of the plant. The Authority will operate the nuclear reactor for the Commission at reimbursable costs and will purchase the steam produced by the reactor at the cost to the Authority of steam production in its most efficient plant. The Authority's investment is estimated at $3,750,000 and the Atomic Energy Commission's at $8.3 million. It is estimated that under the terms of this contract the cost of production of the nuclear power plant will be very near to the Authority's

average costs of power generation. The plant is scheduled for operation in December, 1962. (auth)

7280 THE NUCLEAR-POWER PLANT OF MAMBUCABA. Octavio Augusto Dias Carneiro (Comissão Nacional de Energia Nuclear, Rio De Janeiro). p.351-65 of "Industrial Applications of Nuclear Energy." Washington, D. C., Inter-American Nuclear Energy Commission, 1961. (In Portuguese)

Conditions to be achieved by a nuclear power plant operating by 1966, in the central-southern region, where the interconnected power system then existing will be able to absorb a base load plant with a generating capacity of 150,000 to 200,000 kW, operating with a load factor of not less than 75% in the initial phase of its useful life, are discussed. A preliminary search was made for a suitable site for the first nuclear power plant. The availability of cooling water, good soil conditions for foundations, low population density, proximity to the main load centers, and accessibility were taken into account. The site selected is on the shore of the Mambucaba River and about 140 kilometers from the city of Rio de Janeiro, practically midway between that city and São Paulo, the two largest load centers of the country, and 50 kilometers from the transmission line connecting these two centers. The area has a very low population density and the hydrological characteristics of the Mambucaba River seem favorable. A port and a 5 kilometer road will be constructed for direct access to the works by sea from Rio de Janeiro and from abroad. Late in December 1959, a superintendency was created to which was assigned the economic, administrative, legal, and financial measures relating to the Mambucaba nuclear power project. The studies of the site were initiated by August 1959. (auth)

Power Reactors

Refer also to abstracts 6762, 6763, and 6764

7281 (APEX-135) NUCLEAR AIRCRAFT POWER PLANTS UTILIZING LIQUID CIRCULATING FUEL REACTORS. W. C. Cooley (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). June 1, 1953. Decl. June 9, 1961. 65p. Contract [AT(11-1)-171].

Results are presented for a design study for a series of nuclear power plants for manned turbojet bombers. Each power plant utilizes a liquid circulating fuel reactor, a ternary heat-transfer system, and a quasi-unit shield. The reactor discussed specifically is the ORNL Fireball and the power plants analyzed use, respectively, 8, 6, or 4 modified General Electric J-73 turbojet engines. Performance estimates are presented and comparison is made with two advance-design direct-cycle power plants. A bibliography of reports pertinent to the study is included. (C.H.)

7282 (APEX-213) ANALYSIS OF LPT AND ZPT REACTOR RUNAWAYS. F. W. Mezger (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). June 1, 1953. Contracts AF33(038)-21102 and AT(11-1)-171. 132p.

An analysis was made of possible Low Power Test and Zero Power Test runaways and results are given even though neither test will actually be run. Vaporization of the fuel elements is considered. (D.L.C.)

7283 (APEX-229) CRITICAL EXPERIMENT DATA AND SUPPORTING ANALYSIS FOR THE AC-100A REACTOR. Work performed [during] January 15, 1954 to March 1954. S. H. Minnich, R. M. Cohen, J. S. McCullough, and H. E. Brown (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). May 12, 1954. Decl. June 9, 1961. Contracts AF33(038)-21102 and AT (11-1)-171. 88p.

Preliminary experimental and analytical data are given. Included are discussions of control rod values, power distributions, reactivity coefficients of various fuel elements, and limited reflector measurements. Discussions of two-group constants, cell corrections, control rods, power distributions, reflector and tube sheet analysis, and other analyses are also included in appendices. (P.C.H.)

7284 (APEX-271) AC-111 CRITICALITY STUDIES. W. B. Henderson (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Feb. 23, 1956. Decl. June 9, 1961. Contracts AF33(038)-21102 and AT(11-1)-171. 12p.

Parameter studies of a homogeneous reactor for a single-engine power plant are presented. Effective multiplication as a function of moderator volume fraction and fuel investment is computed for a standard configuration of core plates, reflector, and island. Certain cases are computed for various other core plate, reflector, and island configurations. (auth)

7285 (APEX-345) SUMMARY HAZARDS REPORT FOR CRITICAL EXPERIMENTS WITH THE HOTCE REACTOR. J. A. Hoefer (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Nov. 20, 1957. Contracts AF33(038)-21102 and AT(11-1)-171. 42p.

A solid-moderated critical assembly designed to operate at elevated temperature is described. The experiment program and operating procedures planned for various temperatures are outlined. The hazards of operating the HOTCE in the Low Power Test Facility at the Idaho Test Station were analyzed and the results are set forth in terms of energy and fission fragment release as well as the effect on the surrounding area. (auth)

7286 (BMI-1560) SULFEX-THOREX AND DAREX-THOREX DISSOLUTION OF HIGH-BURNUP CONSOLIDATED EDISON REACTOR FUEL. Robert A. Ewing, Harvey B. Brugger, and Duane N. Sunderman (Battelle Memorial Inst., Columbus, Ohio). Dec. 21, 1961. For Oak Ridge National Lab., Tenn. Contract [W-7405-eng-26]. 44p.

Response of high-burnup prototype Consolidated Edison power-reactor fuel pins to the Darex-Thorex and Sulfex-Thorex head-end processes was investigated on a laboratory scale. Losses of uranium to 6 $\underline{M}$ H_2SO_4 (Sulfex) decladding solutions were in the 0.05 to 0.15% range, for burnups of from about 1000 to 20000 Mwd/t of core. Losses of uranium to dilute aqua regia (Darex) decladding solutions, fairly comparable at 1000 Mwd/t, 0.1 to 0.3%, increased to 1 to 3% at burnups of about 10000 to 20000 Mwd/t. Rate of dissolution of dejacketed fuel cores appeared to be enhanced by irradiation to high burnup. No selectivity of dissolution of core components was apparent. At high burnups, neutron-activated cobalt-60 is a minor contributor to the total activity of decladding solutions. Principal contributors to the radioactivity of decladding solutions are fission products, which, except for cesium, appear to be present in approximately the same proportion as the fuel dissolved. Cesium contents of decladding solutions, though variable, are sufficiently high that they must be taken into account in radiochemical burnup determinations. (auth)

7287 (DC-51-9-5) CRITICALITY IN WATER MODERATED REACTORS WITH METALLIC FUEL ELEMENTS. Austin Corbin (General Electric Co. Aircraft Nuclear

Propulsion Project, Cincinnati). [nd.] Decl. July 18, 1961. 20p. Contract [AT(11-1)-171].

Criticality calculations are presented for water moderated reactors with metallic fuel elements. The reactor is composed of SiO_2 insulating material (8% by volume), Al structural material (4% by volume), H_2O moderator (20 to 40% by volume), and a metallic fuel element containing $U^{235}O_2$, and air. The fuel element was considered as being a metallic sandwich composed of any one of three metals, stainless steel type-310, stainless steel type-309, or 50% stainless steel type-309 + 50% Nb. Both a shelf design and a cylindrical design were considered for the reactor. (C.H.)

7288 (DLCS-2430104) PERIODIC INTERCALIBRATION OF TEMPERATURE SENSING ELEMENTS, CORE I, SEED I. Test Results T-641306. (Duquesne Light Co., Shippingport, Penna.). First issue, Oct. 24, 1960. Second issue, May 16, 1961. Contract [AT(11-1)-292]. 24p.

Intercalibration data for various temperature sensing elements in the reactor coolant system are obtained and compared with calculated source activity levels and observed channel levels. The readings of 20 of the 62 core thermocouples were either less than 400°F, which was off scale on the recorder, or were ±20°F from the calibrating resistance thermometer temperatures. The remainder of the readings were within ±3% of the temperatures of the calibrating thermometers which were used as a standard of comparison. The main coolant loop resistance thermometers all read within ±0.2% of the calibrating thermometers. The data from the nuclear source range instrumentation indicated a level ranging from less than 1.7 cps to 31 cps; Channel A indicating the highest. The recorded source activity levels were generally higher than the calculated source activity levels as they should be. There appeared to be no correlation between coolant temperature and source log level source range indications. (N.W.R.)

7289 (DP-661) CALCULATION OF HEAVY WATER LATTICE PARAMETERS. Frank E. Driggers and Julius C. English (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Nov. 1961. Contract AT(07-2)-1. 44p.

A code is developed to calculate lattice parameters for fuel assemblies consisting of single rods, hexagonal clusters of rods, or concentric tubes of uranium or uranium oxide in a water moderator. The uranium must be unirradiated, and the moderator must be primarily heavy water but may be at any temperature. The code is used to calculate lattice parameters for which bucklings are measured and reported. The standard deviation of the difference between a measured value and the corresponding calculated value is about 0.2 m^{-2}. Further work on the code is planned. The calculation of some of the parameters, for example η and L^2, will be improved. Also, the code will be extended to include lattices of irradiated uranium. (auth)

7290 (EURAEC-173) AN ADVANCED RESEARCH PROGRAM ON THE APPLICATION OF STEAM–WATER SPRAY TO THE COOLING OF LIGHT WATER REACTORS. CAN-2 Quarterly Progress Report No. 1, July 1 to Sept. 30, 1961. (Centro Informazioni Studi Esperienze, Milan). Oct. 15, 1961. Work performed under United States-Euratom Joint Research and Development Program. Contract 060.61.7RDI. 11p. (CISE-R-47)

The heat transfer loop and the modifications made in its design are described. Film measurements on an annular test section and a hydrodynamics loop are described. Progress is reported on the corrosion and erosion part of the program. (D.L.C.)

7291 (NEPA-592) CRITICAL REACTOR SIZES AND WEIGHTS FOR URANIUM CARBIDE–GRAPHITE SYSTEMS. A. O. Mooneyham (Fairchild Engine and Airplane Corp. NEPA Div., Oak Ridge, Tenn.). June 15, 1948. Decl. July 18, 1961. 31p. Contract [W-33-08-ac-14801(16250)].

Criticality requirements for cylindrical, air-cooled, room temperature, homogeneous uranium carbide-graphite reactors utilizing completely enriched uranium and having graphite reflectors were determined. Results are presented in the form of graphs relating uranium weight, total reactor weight, reactor size, core composition, reflector thickness, and free flow ratio. The data are intended only for assisting in the selection of design points from a wide range of variables, and are not considered adequate for prediction of critical masses in actual critical assemblies. Some neutron flux spatial distributions are given. Also included are neutron flux energy distributions, fissioning energy distributions, and mean times between fissions for several reactors without reflectors. (auth)

7292 (NEPA-1009) REFLECTOR REMOVAL AS A MEANS OF PILE CONTROL. Mary Shirley Johnson and J. W. Webster (Fairchild Engine and Airplane Corp. NEPA Div., Oak Ridge, Tenn.). May 3, 1949. Decl. July 18, 1961. Contract [W-33-08-ac-14801(16250)]. 12p.

The effect on reactivity of removing an all-over reflector from a square cylinder reactor is discussed, and a means of estimating the effect of removing a portion, e.g. the ends, is provided. By removing an all-over reflector from a reactor, it is possible to obtain up to about 50% change in reactivity, this upper limit being in fast piles. The available control increases also with the thickness of the reflector, but not much is gained for thickness of more than 6 or 8 inches. It was concluded from the results obtained that adequate control could be achieved in fast and intermediate reactors with a not unreasonable distortion of the reflector. (auth)

7293 (NEPA-1476) SURVEY OF NONMETALLIC LIQUID COOLANTS FOR NUCLEAR-POWER PILES. H. L. Shaw and F. W. Boulger (Battelle Memorial Inst., Columbus, Ohio). May 26, 1950. For Fairchild Engine and Airplane Corp. NEPA Div., Oak Ridge, Tenn. Contract [W-33-08-ac-14801(16250)]. 31p.

A comprehensive survey of the literature was made in an effort to identify nonmetallic materials of possible usefulness as liquid coolants. Materials having maximum melting points of 1000°F and boiling points of 1200°F were considered, but boiling points above 2200°F were preferred. Melting points, boiling points, densities, heat capacities, and thermal conductivities were tabulated. Approximately 190 materials appeared to have melting and boiling temperatures in a suitable range. A paucity of thermal-conductivity and heat-capacity data prevented further estimates of suitability of all but nine of these materials. Of these nine nonmetallics, only sodium hydroxide appeared to offer possibilities when considered according to the NEPA formula. (M.C.G.)

7294 (NEPA-1590) STUDY OF GENERALIZED DILUENTS IN REACTORS OF FIXED GEOMETRY. W. H. Long (Fairchild Engine and Airplane Corp. NEPA Div., Oak Ridge, Tenn.). Oct. 20, 1950. Contract [W-33-08-ac-14801(16250)]. 64p.

Calculated critical masses as a function of diluent cross sections varying as $1/v$ or $1/v^{\frac{1}{2}}$ are presented graphically for reactors of a fixed size (2.5 ft core diam). Four moderators, Be metal, BeO, and two Be_2C with added graphite were studied and compared. Various effects such as production spectra, variation of critical mass with core

diameter and reflector savings and variation of median energy for fission with diluent absorption are included as illustrative material. An exposition of methods and assumptions is given with references to sources. (auth)

7295 (TID-7617) NUCLEAR SUPERHEAT MEETING NO. 4, APRIL 13 AND 14, 1961, IDAHO FALLS, IDAHO. Andrew E. Mravca and Daniel E. Simpson (Chicago Operations Office, AEC). Apr. 28, 1961. 71p. (COO-263)

Minutes are presented on the fourth Nuclear Superheat Meeting. The status of BORAX-V, BONUS, Pathfinder, and VESR is discussed. Other developments of nuclear superheaters are outlined. (M.C.G.)

7296 (WAPD-PWR-1606(Rev.)) THE SHIPPINGPORT PRESSURIZED WATER REACTOR PROJECT CATALOG OF DOCUMENT ABSTRACTS. (Westinghouse Electric Co. Bettis Atomic Power Lab., Pittsburgh). Dec. 1961. Contract AT-11-1-GEN-14. 313p.

This catalog of abstracts lists documents currently available on the Shippingport Pressurized Water Reactor Project. The subjects cover aspects of the operation and testing of the reactor including chemistry, core development, physics, reactor engineering, power plant operation, and metallurgy. (N.W.R.)

7297 (WAPD-PWR-TE-84) SHIPPINGPORT PWR-1 SEED 2 PHYSICS TEST RESULTS FROM 6200 EFPH TO THE END OF SEED 2 LIFE. G. W. Saito (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Oct. 27, 1961. Contract [AT(11-1)-Gen-14]. 31p.

Physics tests were performed on PWR-1 Seed 2 between 6200 and 7900 EFPH to provide information on control rod bank critical positions and reactivity worths, excess reactivities, temperature coefficients, xenon transient characteristics, and core reactivity symmetry measurements. The 7528 EFPH reactivity worth measurements resulted in a pronounced increase of the rod bank worth at rod positions high in the core due to fuel depletion effects. Values of xenon-free excess reactivities at ambient and operating temperatures measured at 7528 EFPH were computed by graphical integration of control rod worth curves. The zero power temperature coefficient measured at 7528 EFPH continued to exhibit a behavior consistent with Seed 1 experience by decreasing in absolute magnitude during Seed 2 life. The average seed thermal neutron flux level inferred at 7528 EFPH from a xenon transient measurement continued the over-all increasing trend of Seed 2 flux values with core age resulting from fuel depletion control rod group reactivity worth measurements during a xenon transient were not observed to differ appreciably from previous measurements. The end of life core reactivity symmetry measurements at 7528 EFPH showed no appreciable asymmetrical radial fuel depletion and fission product poisoning effects to be in evidence. The blanket power share was higher during Seed 2 operation than predicted by depletion calculations. (M.C.G.)

7298 (WAPD-PWR-TE-116) SHIPPINGPORT PWR-1 SEED 2 SPECIAL PHYSICS TEST RESULTS. Test Evaluation. G. H. Saito and J. H. Leonard (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Oct. 27, 1961. Contract AT-11-1-GEN-14. 20p.

Three special purpose physics tests were performed to investigate certain nuclear characteristics of PWR-1. The axial flux perturbation was inconclusive with regard to the cause of previous control rod position fluctuations. The radial flux perturbation test revealed a damped radial oscillation power behavior. The samarium transient test indicated a measurable reactivity effect from the buildup of samarium. (M.C.G.)

7299 (WAPD-T-1383(Rev.1)) AN EVALUATION OF THE "ZIP" SYNTHESIS DEPLETION TECHNIQUE AS APPLIED TO A PWR SEED-BLANKET SLAB REACTOR. C. D. Sphar (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Sept. 1961. Contract AT(11-1)-Gen-14.

Presented at ANS Meeting, Chicago, Nov. 1961.

The "ZIP" synthesis depletion technique is being employed as a design tool to determine the nuclear behavior of PWR Core 2. A study of the applicability of the technique to seed blanket cores of the PWR type was undertaken by applying it to a fictitious, two-dimensional, seed-blanket, slab reactor specifically designed to provide a stringent test of the mathematical assumptions involved. A two-dimensional depletion calculation for the slab reactor was assumed to represent reality for the purposes of the study and provided a basis for evaluating synthesis results. In general the synthesis technique was fairly successful in predicting the nuclear behavior of this fictitious core and it was concluded that the use of the synthesis approximation as a PWR Core 2 design tool appears to be justified. (auth)

7300 (WCAP-4060) CAROLINAS VIRGINIA NUCLEAR POWER ASSOCIATES, INC., CVTR PROJECT MONTHLY PROGRESS REPORT, OCTOBER 1961. (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). Contract AT(30-1)-2289. 17p.

The Phase II tests were terminated with the completion of the final vacuum drying test, which was conducted on the empty U-tube. The reusable baffle feature of the four baffle, outlet leg fuel assembly was successfully tested. Impulse burst testing of pressure tubes was resumed. A slightly hydrided specimen exhibited ductile behavior similar to non-hydrided specimens. Work on the hydrodynamic stability program was completed. Testing of the control rod drive train system was resumed. The black control rod was successfully scrammed over 2600 times. The gray rod was cycled up and down 3700 times by the end of the month toward a goal of 6000 cycles. (auth)

7301 (XDC-58-4-58) THE EFFECT OF BERYLLIUM PHOTONEUTRONS ON REACTIVITY. R. K. Lane (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Mar. 11, 1958. Decl. June 9, 1961. Contract [AT(11-1)-171]. 24p.

A method of calculating the contribution to reactivity from beryllium photoneutrons is presented. The analysis includes a gamma slowing down density calculation which may be useful for gamma heating calculations. (auth)

7302 (XDC-59-10-201) NUCLEAR ANALYSIS OF THE HOTCE REACTOR. PART I. REACTIVITY-TEMPERATURE RELATIONSHIP. D. E. Wetzel (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Sept. 1, 1959. Decl. July 6, 1961. Contracts AT(11-1)-171; AF33(038)-21102; and AF33(600)-38062. 26p.

An analysis of the Hot Critical Experiment (HOTCE) performed at the Low Power Test Facility at the Idaho Test Station is presented, and current analytical methods of determining temperature effects on reactivity in heterogeneous, hydrided zirconium moderated reactors are evaluated. Results show good theory-experiment agreement on system multiplication at 68°F; however, temperature effects while having the correct sign, were of incorrect magnitude. Indications are that the inability of current analytical methods to predict correct magnitude of temperature effects is due to the incorrect treatment of thermal and non-thermal neutrons in the slowing-down calculation. (auth)

7303 THE COST STRUCTURE OF THE KILOWATT PRICE IN ELECTRICAL ENERGY FROM NUCLEAR ENERGY. A. E. Lindo. Atoomenergie, 3: 199-210(Oct. 1961). (In Dutch)

After a brief discussion of the present situation of electricity supply in the Netherlands, the role which nuclear energy power plants can play is reviewed. A description is given of the fixed and variable costs in such a power plant. (tr-auth)

7304 SRE OPERATES AGAIN WITH CORE-2 – BUT WITH 5-Mw(th) POWER LIMIT. Nucleonics, 20: No. 1, 74; 76(Jan. 1962).

Start-up operations and reactivity problems of the Sodium Reactor Experiment with core-2 are discussed. The core-2 fuel elements are slugs of thorium alloyed with 7.6 wt % of 93.13%-enriched uranium. The power level is restricted to one-quarter of the 20-Mw(th) design value until carbon deposits can be extracted from the sodium coolant. The method for removing the carbon deposits is described. A brief discussion is also given on the possibility of raising the power level to 40-Mw(th) after improved fuel elements and heat transfer components are installed later. (N.W.R.)

7305 INTRODUCTION TO THE METHODS OF ESTIMATING NUCLEAR POWER GENERATING COSTS. Technical Reports Series No. 5. (International Atomic Energy Agency, Vienna). 1961. 72p. (STI/DOC/10/5). $1.00(IAEA).

A full list of the cost items likely to be encountered in the design, construction, and operation of a nuclear power plant is presented. The three categories of nuclear power costs, plant construction, fuel, and operation and maintenance are discussed in detail. Current methods of generating cost calculations are outlined and the limitation to which they may be subject discussed. (M.C.G.)

7306 POWER REACTOR TECHNOLOGY. Technical Progress Review, Vol. 5, No. 1. Walter H. Zinn (General Nuclear Engineering Corp., Dunedin, Fla.). Dec. 1961. 95p. $0.55(GPO) (Domestic), $0.70(GPO) (Foreign).

Developments in reactor technology for civilian applications are reviewed. Topics discussed include fuel cycle; reactor physics; heat transfer; reactor dynamics; recent SPERT results; reactor containment; nuclear instrumentation systems; fuel elements; materials; nondestructive testing; design practice; evaluation of material fatigue for pressure-vessel design and analysis; operating experience; pressurized-water reactors, internal pressurization; gas-cooled reactors; sodium-cooled reactors; SRE fuel-element damage; and the Experimental Organic-Cooled Reactor. (M.C.G.)

Production Reactors

7307 STEAM TURBINES DRIVE NPR MAIN PUMPS. George T. Lewis, Jr. (Burns and Roe, Inc., New York). Nucleonics, 20: No. 1, 77-8(Jan. 1962).

The steam-turbine drive system for the Hanford Production Reactor (NPR) main cooling system pumps is described along with the pump systems and the centrifugal pumps themselves. The steam-turbine drive system is chosen rather than electric motors for driving the main pumps because of lower capital and operating costs. The pump-seal system is described for the five conventional limited-leakage centrifugal pumps. (N.W.R.)

Research Reactors

Refer also to abstract 6903

7308 (IDO-16719) ETR THERMAL NEUTRON FLUX MEASUREMENTS FOR CYCLE 27. L. D. Weber and C. H. Hogg (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Dec. 14, 1961. Contract AT(10-1)-205. 159p.

The thermal neutron fluxes in selected positions of the ETR were measured for Cycle 27. The measurements include data for the beginning of the cycle (0 MWD), throughout the cycle, and the end of the cycle (4467 MWD). Vertical traverses for each position monitored are shown. Cadmium ratios calculated for "thin" cobalt are included for various positions. (auth)

7309 THE DISCOVERY OF THE PRINCIPLE OF THE PULSE REACTOR. K. Fuchs (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Kernenergie, 4: 685-7(Sept. 1961). (In German)

The results of calculations made in 1945 which led to the discovery of the principle of the pulse reactor were published, but the calculations themselves have never been published. The present article presents these calculations. The calculations are concerned with the analysis of an experiment in which fissionable materials arranged in a critical arrangement were exposed to fast neutrons so that a supercritical condition resulted. The variation of the criticality depends on the geometric alteration of the arrangement and on the thermal expansion of the system caused by the fission energy. Calculations for the neutron flux, neutron pulse, combination of the equations, and the second pulse are given. (J.S.R.)

7310 A NOMOGRAM FOR THE CALCULATION OF NEGATIVE REACTIVITY AS A RESULT OF XENON POISONING AT THE END OF SHUTDOWN FOR THE ROSSENDORF RESEARCH REACTOR. G. Ackermann (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Kernenergie, 4: 688-92(Sept. 1961). (In German)

For an approximate calculation of the negative reactivity from xenon poisoning in the Rossendorf Research Reactor, a nomograph was developed which has proved itself as a calculation auxiliary. The deviations of the reactivity values calculated with this nomograph from the measured values are less than 10%. (tr-auth)

7311 EXPERIMENTAL ANALYSIS OF THE USE OF THE "EWA" REACTOR TO SOME PILE-OSCILLATOR MEASUREMENTS. Jacek Boużyk, Wacław Dąbek, Cyryl Dąbrowski, Krystyna Józefowicz, Jerzy Kożmiński, Witold Suwalski, Jerzy Topa, and Zbigniew Weiss (Inst. of Nuclear Research, Polish Academy of Science, Warsaw). Nukleonika, 6: 717-34(1961). (In English)

For the EWA reactor the sensitivity of moderator-purity determinations by three pile-oscillator methods, namely the global, local, and resultant signal ones, was analyzed. The sensitivity definitions for the three methods and the relation between the resultant signal sensitivity and the remaining ones are given. The measurements were performed both statically and kinetically. The measured sensitivity values in the core amount, for graphite, to 0.8 promille of the signal amplitude per 1 ppm in the global and local signal methods and not more than 0.3° of the resultant signal phase angle per 1 ppm. Two kinetic reactor parameters, namely the amplification factor A and the delay angle φ, of the global signal relative to the sample motion for oscillation periods from 1 to 22 seconds were determined. These results permit an estimation of the ef-

fective delayed neutron fraction and the mean prompt neutron lifetime in the reactor. (auth)

7312 POWER CALIBRATION OF A POOL-TYPE RESEARCH REACTOR. Arnold M. Plummer (Battelle Memorial Inst., Columbus, Ohio). Research Reactor J., 1: No. 1, 4-7; 17(Oct. 1960).

The calibration and regulation of power output based on operating experience with the Battelle Research Reactor are discussed. Experience indicates that an error of ±10 to 20% must be admitted in power determinations under operating conditions. Of the various power calibration techniques, measurement of the flow rate and ΔT across the primary and secondary heat exchanger has proved to be the most practical for long term monitoring power at the BRR. Measurement of the ΔT across the core appears to be the most practical instantaneous power monitor, but is limited by the large number of temperature sensors necessary for the accurate average inlet and outlet temperatures required when ΔT is small. (N.W.R.)

7313 JAPANESE RESEARCH REACTOR-2. Toyozo Kambara (Japanese Atomic Energy Research Inst., Tokyo). Research Reactor J., 1: No. 2, 1-3(Jan. 1961).

The general specifications and characteristics of the Japanese Research Reactor-2 (JRR-2) are given. The JRR-2 is a CP-5 type, heavy water moderated and cooled heterogeneous reactor using 20% enriched uranium as fuel, with 2×10^{14} n/cm^2/sec thermal neutron flux density. (N.W.R.)

7314 CONTROL AND MAINTENANCE OF THE MCMASTER REACTOR COOLING SYSTEMS. J. B. McDougall (McMaster Univ., Hamilton, Ont.). Research Reactor J., 1: No. 2, 4-7(Jan. 1961).

The McMaster Nuclear Reactor is a 1 Mw pool-type research reactor in which the heat absorbed from the core by the water of the primary cooling circuit is transferred in an all aluminum heat exchanger to water in a secondary cooling system. By circulating the secondary coolant through a double flow cooling tower, the heat is dissipated to the atmosphere outside of the reactor building. The primary coolant for the MNR is dimeralized water. The purity and pH of the water is controlled by use of two ion exchange units. City water is the secondary coolant and it is treated according to a local water consultant. The maintenance program for the reactor system is described along with the water treatment methods. (N.W.R.)

7315 (PUERTO RICO NUCLEAR REACTOR USES NEW TYPE FUEL ELEMENTS. R. J. Beaver and T. E. Cole (Oak Ridge National Lab., Tenn.). Research Reactor J., 1: No. 2, 8-12(Jan. 1961).

The path set forth in arriving at the U_3O_8 fuel element design for the Puerto Rico Nuclear Center research reactor is discussed. The fuel element is generally referred to as MTR-type and contains 20% enriched uranium. (N.W.R.)

7316 A NEW HIGH POWER CORE FOR POOL REACTORS. John MacPhee (AMF Atomics, Inc., New York). Research Reactor J., 1: No. 3, 10-14(Apr. 1961).

A description is given of the core assembly of the 40 Mw Pressure Tube Reactor (PTR), and the features and advantages of the PTR are discussed. The arrangement of the core is shown. The fuel elements are mounted on a plenum assembly made up of two toroidal shaped coolant mainfolds enclosed by three grid plates. The core is designed in such a manner that the coolant is isolated from the pool thereby permitting coolant pressurization and minimizing activation of shield water. (N.W.R.)

7317 THE IRL FIVE-MEGAWATT REACTOR. Paul E. F. Thurlow (AMF Atomics, Inc., New York). Research Reactor J., 2: No. 1, 1-7(Oct. 1961).

Technical information and operating characteristics are presented on the successful operation of the Industrial Reactor Laboratories (IRL) pool-type research reactor at five megawatts. In addition, the initial operating data indicates no limitation inherent in the design of such a system which would preclude further increases in the power level up to the 10 megawatt range. The design features of the reactor are described. (N.W.R.)

7318 AN ENGINEERING CRITICAL EXPERIMENT USING THE IRL REACTOR. J. MacPhee, R. R. Powell, O. A. Schulze, and P. M. Williams (AMF Atomics, Inc., New York). Research Reactor J., 2: No. 1, 11-16(Oct. 1961).

An engineering critical experiment of the Pressure Tube Reactor (PTR) core using the facilities of the Industrial Reactor Laboratories pool-type research reactor is described and some of the results are presented. The experiment was planned and performed so that both engineering and physics objectives would be realized simultaneously and costs minimized. Successful data are obtained on the following engineering and physics objectives: control rod performance; performance of fuel handling tools; compatibility with pool reactor instrumentation; general suitability of component design to a pool type installation; mass coefficients; cadmium ratios; critical mass; control rod worths; reactivity effects of void, boron, aluminum, and stainless steel; and detailed flux distributions. (N.W.R.)

7319 A POWERFUL RESEARCH REACTOR. D. M. Kaminker. Vestnik Akad. Nauk S.S.S.R., 31: No. 10, 60-4 (Oct. 1961). (In Russian)

A maximum neutron flux of 3×10^{14} neutrons/cm^2-sec and a thermal power of 10 megawatts were attained in VVR-M type of reactor (boiling water reactor) in the Physical-technical Institute of A. F. Joffe by developing a tubular type of fuel element. The heat transfer surface is increased by a factor of four in a tubular fuel element as compared to a slug type of fuel element. The active zone is surrounded by a beryllium reflector. The reactor is equipped with 10 horizontal beam holes and a thermal column with associated equipment. One of the beam holes has a four-meter, crystal-diffraction spectrometer for studying γ-rays from an (n,γ) reaction, and low-lying energy levels in odd-odd nuclei (E < 1.5 Mev). Another two-meter, crystal-diffraction spectrometer is used to study the Mossbauer effect which has been observed for the 46- and 99-Mev levels in W^{183}. A pneumatic tube is used to deliver an isotope within a 0.1 second to the vacuum chamber of a spectrometer ($\pi\sqrt{2}$). The correlation between conversion electrons and the circular polarization of γ-quanta in the decay of F^{20} and Pr^{144} was measured with this equipment. A sample can be displaced from the neutron beam in 0.04 seconds to a special shielded, scintillation spectrometer at a distance of 0.5 m. This operation is performed by means of a spring-loaded pendulum controlled by electromagnets. Measurements of the internal conversion coefficients for the isomeric transitions in Hf^{179}, W^{183m}, In^{114}, Yb^{177}, and Yb^{175} with respective half-lives of 19, 5.5, 2.5, 6.5, and 0.06 seconds were carried out with this arrangement. Neutron beams with 80% polarization can be obtained for various experiments. A neutron chopper is employed to obtain a monochromatic beam of slow neutrons for various studies. (TTT)

7320 THE DETERMINATION OF THE SPECTRAL DISTRIBUTION OF THE EPITHERMAL AND FAST NEU-

TRONS FOR THE CORE OF A SWIMMING POOL REACTOR. W. Koehler (Technische Hochschule, Munich). Z. Naturforsch., 16a: 936-45(Sept. 1961). (In German)

The energy distribution of the epithermal and fast neutrons were calculated for the core of a light-water moderated reactor and measured for a position between the fuel plates and in a central irradiation channel with activation detectors. The measurements for a position between the fuel plates near the center of the core agree within the limits of error with the calculated pattern. (tr-auth)

SPACE APPLICATIONS AND TECHNOLOGY

7321 (ARL-57) THEORETICAL RESEARCH ON THE STORAGE OF HIGH TEMPERATURE GASES. F. S. Roehrs (Flight Sciences Lab., Inc., Buffalo). July 1961. Contract AF33(616)-6533. 72p.

The results are described of an analytic study of the heat transfer problems associated with the storage of high-temperature gases. Analytic discussions of the basic concepts of radiant heat transfer, conductive heat transfer, and chemical boundary layers are presented with particular emphasis on those features which are important for the storage problem. Analytic expressions for characteristic radiation lengths, characteristic radiative cooling rates, and characteristic conductive cooling times are developed and evaluated in a numerical study of hydrogen, helium, argon, and air. The temperature range for these studies extends from 2,500°K to values associated with complete first ionization of the constituent atoms; the pressure values are 10^{-2}, 10^{-1}, 1, 10, and 100 atm. The numerical studies clearly demonstrate the fact that the practical storage of high-temperature gases will be limited to temperatures below the onset of the important bound-free radiation processes. In hydrogen, this temperature limit is very low (2,600°K) due to the formation of the negative ion H^-. In the case of helium, however, the limiting temperature is unusually high (8,300°K) as a consequence of the high ionization potential. The influence of heterogeneous chemical reactions is shown to be limited to a very thin chemical boundary layer which can be ignored in analytic studies of the temperature profiles. (auth)

7322 (ARL-60) CHEMICAL REACTIONS TO CONVERT SOLAR ENERGY INTO POWER SOURCES. J. J. Rowlette (Electro-Optical Systems, Inc., Pasadena, Calif.). Apr. 1961. Contract AF33(616)-6546. 44p.

Photochemical synthesis of hydrogen peroxide and the combined thermal-photochemical decomposition of sulfur trioxide were the goals of the program described. The interest in these studies lies in the ultimate possibility of using sunlight for regenerative electrolytic cells, or for the purpose of making hydrogen peroxide for other high energy applications. A theoretical examination indicated the possibility of achieving conversion efficiencies higher than those obtainable by any present device, although only some very general outlines of an approach to the problem are apparent at this time. A rather careful theoretical analysis of the photolysis and thermal decomposition of sulfur trioxide strongly indicated that a combination of a photochemical and thermal decomposition would not yield a decomposition greater than the two processes used separately. For this reason, the experimental work was limited completely to the photochemical synthesis of hydrogen peroxide. Hydrogen peroxide synthesis was accomplished in both liquid and gaseous states using cadmium telluride and zinc oxide as photocatalysts in each case. In the absence of organic additives in the liquid phase, neither catalyst showed any promise. In the presence of the additives, quantum efficiencies were quite high under some circumstances but the reactions were always exothermic and consequently of no value for energy conversion. However, it was found that the reaction could be performed in the gas phase in a flow system using solid photosensitizers. These reactions are almost certainly endothermic and therefore represent energy conversion. (auth)

7323 (ARL-TR-60-320) ANALYTICAL STUDIES ON ION PROPULSION. J. H. Molitor and T. M. Littman (Rocketdyne. Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 1961. Contract AF49(638)-649. 266p.

Major problems associated with ion rocket engine system components are discussed. Electrical power generation systems, thermal power conversion, and accelerating electrode configurations are explored in component studies. Thrust devices and propellants for electrical propulsion are considered. A mission analysis and a space powerplant study are made. (D.L.C.)

7324 (D2-5523) COLLECTION OF SOLAR THERMAL ENERGY FOR SPACE POWER SYSTEM APPLICATION. N. R. Griswold (Boeing Airplane Co., Seattle). Jan. 11, 1960. 35p.

Data were developed which give a realistic approach to the problems of collection, concentration, and absorption of solar energy for use with the thermal conversion devices. The information presented represents estimates of what can be accomplished in the solar-thermal energy field. The basic assumptions used, in most cases, are slightly optimistic, however they result in achievable optimum collector–absorber system efficiencies. The information is presented in the form of general equations and resulting curves. The derivations and development of the equations is carried only to the point of stating the assumptions and limitations. A "tool" for determining first approximations of the efficiency value to be assigned to solar thermal power system is thus provided. From a brief comparison of the more advanced solar thermal systems it appeared that until specific conditions are met simultaneously the solar cell power systems will remain the only solar power source considered for space application. (auth)

7325 (MAB-177-M) REPORT BY THE COMMITTEE ON MATERIALS ASPECTS OF AUXILIARY POWER UNITS FOR USE IN SPACE VEHICLES. (National Research Council. Materials Advisory Board). Oct. 25, 1961. 159p.

Materials problems associated with power conversion units are discussed. Chemical, solar, and nuclear energy sources were considered along with mechanical, thermionic, thermoelectric, photovoltaic, and direct conversion techniques. Effects of the external environment encountered by space vehicles are also discussed. (M.C.G.)

7326 (MND-P-3014-III) SNAP PROGRAMS. Quarterly Progress Report No. 6, January 1 through March 31, 1961. Task 6. Fuel Technology Development Program. (Martin Co. Nuclear Div., Baltimore). Contract AT(30-3)-217. 72p.

Isotope power sources are being developed for use in thermionic and thermoelectric power generators for space applications. Suitable radioisotope fuels and heat source containment capsules are being designed for SNAP-type generators with land, sea and space applications. Curium-242 and Plutonium-238 are currently being investigated, and methods for purification, compound conversion and fuel form are being established. A Heavy Elements Processing Facility capable of handling and preparing gram quantities of Am^{241} in an aluminum matrix for irradiation to Cm is being activated. In the facility, high integrity aluminum capsules were produced through special encapsulation and

welding techniques. Curium purification by ion exchange techniques is under study to determine the operating conditions and design parameters for the Hot Cell Facility. Following a screening process, these container materials were selected for further investigation: Hastelloy C and Inconel X for thermoelectric applications and a Mo-W combination for the curium thermionic generator. Safety, thermal and shielding analyses were conducted on the processes being developed as well as during handling and shipping. (auth)

7327 (NP-11210) SPACE PROGRAMS SUMMARY NO. 37-9, VOLUME I FOR THE PERIOD MARCH 1, 1961 TO MAY 1, 1961. (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). June 1, 1961. Contract NASw-6. 104p.

A spacecraft-vehicle compatibility test using the Ranger RA-1 proof test model and Agena No. 6001 was successfully completed. Magnetometer calibrations and preliminary system tests were completed on Ranger RA-2. Work is being completed on Centaur and Mariner project development plans. Contact with the planet Venus by coherent CW radar was successfully made. More accurate measurements of the astronomical unit were obtained. Ranging, reflectivity, polarization, and true doppler measurements were made. More accurate measurements of the astronomical unit were obtained. Progress and launch operations in the Juno II program are reported. (M.C.G.)

WASTE DISPOSAL AND PROCESSING

Refer also to abstract 7267

7328 (TID-14472) FOAM SEPARATION. Quarterly Progress Report No. 4, July 1, 1961 to September 31, 1961. J. J. Weinstock, E. Rubin, and E. Schonfeld (Radiation Applications Inc., Long Island City, N. Y.). Oct. 25, 1961. For Oak Ridge National Lab., Tenn. Contract [W-7405-eng-26], Subcontract 2024. 42p.

Extensive studies on the effect of pH and Ca^{2+} concentration on separation of Cs^{+} and Sr^{2+} were conducted. The experimental results indicated that the best pH for separation of both Sr^{2+} and Cs^{+} is the neutral range. However, in the case of Sr^{2+} good separations can be obtained over a wide pH range (3 to 13) whereas for Cs^{+} good separations can be obtained only over a much narrower range (5 to 8). Ca^{2+} had a negative effect on separation of both Sr^{2+} and Cs^{+}. The distribution factors decreased rapidly when Ca^{2+} concentrations were between 10^{-5} to 10^{-4} M/l. Three series of experiments were conducted with sodium dodecyl benzene sulfonate (DBS). The surface excess for DBS was determined by the static and dynamic methods. The results obtained with both methods agreed with the Gibbs adsorption equation. DBS was also used for separation of Sr^{2+} (dynamic method) in presence of NaOH and Ca^{2+}. Promising results were obtained. ORNL low level waste was treated with NaOH. Good separations of Sr^{2+} were obtained from the treated low level waste using DBS as foaming agent. Some additional enrichment tests were conducted with various foaming agents, as part of the screening program. The foam breaker performance was improved by employing a teflon liner. (auth)

7329 (AEC-tr-4954) TREATMENT OF RADIOACTIVE RESIDUES AT MOL. P. Dejonghe. Translated by Martha Gerrard (Oak Ridge National Lab., Tenn.) from Bull. inform. assoc. belge develop. pacifique energie atomique, No. 32, 5-7: 9-11(May 1961). 5p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 15, abstract no. 30329.

7330 (CEA-tr-R-1427) SORPTION DES PRODUITS DE FISSION A LONGUE PERIODE PAR LES SOLS ET MINERAUX ARGILEUX. I. (Sorption of Long-Lived Fission Products by Soils and Clayey Minerals. I). Yu. A. Kokotov, R. F. Popova, and A. P. Urbanyuk (Urbaniuk). Translated into French from Radiokhimiya, 3: 199-206 (1961). 25p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 15, abstract no. 30683.

7331 ENGINEERING AND ECONOMIC PROBLEMS ON THE REMOVAL OF RADIOACTIVE WASTES. Rudolf Rometsch (EUROCHEMIC, Mol, Belg.). Atom u. Strom, 7: 71-4(Oct. 1961). (In German)

In reactor operation, in the production and utilization of artificial radioisotopes, in the processing of natural radioelements, and in the processing of irradiated fuel materials, radioactive wastes are produced and must be removed and made safe. The engineering and economic problems related to the removal of these radioactive wastes are reviewed, and the methods used by Eurochemic in Belgium are emphasized. (J.S.R.)

7332 PERFORMANCE OF THE RADIOACTIVE WASTE DISPOSAL SYSTEM AT THE SHIPPINGPORT STATION. C. S. Abrams, Wilfred J. Hahn, and Jacques R. LaPointe (Westinghouse Electric Corp., Pittsburgh). Chem. Eng. Progr., 58: 70-8(Jan. 1962).

An evaluation is given of the waste disposal system of the Shippingport station which has been in operation for more than three years. The evaluation covers the operation of the system in which the pressurized water reactor plant has operated from initial power, through a refueling, and back to power. The results show that the total quantity of radioactivity discharged to date is approximately 20% of that which is allowed in the system design. (N.W.R.)

7333 LIQUID RADIOACTIVE WASTE HANDLING. Warren Kiedaisch (Commonwealth Edison Co., [Chicago]). Chem. Eng. Progr., 58: 79-81(Jan. 1962).

The operating experiences for safely handling radioactive wastes at the Dresden Power Reactor Station are outlined and evaluated. Results show that the waste system successfully handled the waste load during initial critical experiments, through the half power and full power operating phases, and through several shutdown periods of varying lengths. The operating experience gained during the first year of operation served to point out some of the changes that could be made to improve the system. Several changes made to improve and streamline the system are described and savings made from these changes are pointed out. (N.W.R.)

7334 RADIOACTIVE WASTE SYSTEMS FOR A SODIUM-COOLED REACTOR. Ralph L. Cummings (Atomics International, Canoga Park, Calif.). Chem. Eng. Progr., 58: 82-4(Jan. 1962).

A proposed radioactive waste handling system capable of processing wastes of a 360 Mw sodium-cooled, graphite-moderated reactor station is described. The design of the waste disposal facilities is similar to the system used for the Sodium Reactor Experiment and the system of the 75 Mw Hallam Power Reactor Station. (N.W.R.)

7335 THE SUITABILITY OF PEAT FOR THE PURIFICATION OF RADIOACTIVE WASTES. I. PEAT AS CATION EXCHANGER. R. Winkler and J. Gens (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Isotopentechnik, 1: 219-21(Sept. 1961). (In German)

The exchange of Cs^{+}, Sr^{2+}, and Ce^{3+} ions on peat was investigated under static and dynamic conditions. It was shown that properly prepared peat is principally suitable for the separation of cationic radioisotopes from water. Its applicability was limited by the dissolution of humic acid at pH above 6 to 7, the low sorptive values for alkali ions, and a perturbation effect of inactive salts when they are present in high concentrations. (tr-auth)

7336 PURIFICATION OF RADIOACTIVE WASTE SOLUTIONS WITH NATURAL INORGANIC ION EXCHANGERS. II. THE EXCHANGE OF CESIUM AND STRONTIUM IONS ON RADGENDORF CLAY. G. Sachse (Zentralinstitut für Kernphysik, Rossendorf, Ger.) and E. Leibnitz. Kernenergie, 4: 697-700(Sept. 1961). (In German)

The research and measurement methods used in the determination of the exchange properties are described. For characterization of the applicability of Radgendorf clay as an ion exchanger, the results are given for exchange velocity, effect of pH, grain size influence, and temperature dependence for cesium and strontium. The exchange capacity of the clay can be determined with the help of agitation and column studies. For the column research a stabilization of

the clay was necessary. In order to obtain a survey on the changes in the exchange capacity caused by inactive salts such as $NaNO_3$, $Ca(NO_3)_2$, and $Al(NO_3)_3$, comparative studies were made. The cesium selectivity of the clay was established. On the basis of this selectivity, samples of Radgendorf clay are suitable for the separation of Cs^{137} and Sr^{90}. The possibility of separating Cs^{137} from fission product mixtures for the preparation of radioactive sources is shown. (tr-auth)

7337 APPLICATION OF BENTONITES AND VERMICULITES TO THE DECONTAMINATION OF WASTE WATERS. Werner Hoffmann and Ulrich Hofmann (Farbwerke Hoechst A. G., Frankfurt am Main and Universität, Heidelberg, Ger.). Nukleonik, 3: 195-200(Oct. 1961). (In German)

Eight bentonites and three vermiculites were investigated with respect to their possible utilization in the decontamination of waste waters. With two exceptions (Geisenheimer bentonites) the tested bentonites proved unsuitable for filling flow-through columns as they swell too much. Also as precipitation reagents in salt and carrier solutions of radionuclides they are poor to use as no sufficient decontamination factors were attained. Papers, which contain bentonite as filler, do not swell. They also, however, are not suitable as fillers for columns as the activities given up break through immediately. In the filtration of contaminated water solutions over papers prepared in this manner a decontamination factor with a maximum of seven can be obtained. Vermiculites show the advantage, with respect to bentonites, of lower exchange velocities. The exfoliated samples of these minerals take, however, a very large volume so that the capacity per volume unit is too low and the columns are too large. The Geisenheimer bentonite, on the contrary, can be fabricated into briquets, which do not lose their permeability in columns filled at a throughput of >100 l/kg. In an installation which contains columns filled with briquets of Geisenheimer bentonite, it could be shown that decontamination factors of 10^4 could be attained in contaminated tap water, whereas in polluted sewage decontamination factors of only 10^3 could be obtained. (tr-auth)

CORPORATE AUTHOR INDEX

This index contains entries for all report literature and, in addition, for certain published literature items for which it is felt that a corporate approach is especially desirable, e.g., symposia, conference proceedings, and meetings.

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As an aid to the users of this index, references to report numbers, where appropriate, are included after the abstract number of the citation.

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1221*	16-6716	Dep.(mc); $1.60(fs), $0.80(mf) OTS
1263*	16-6902	$2.60(fs), $0.98(mf) OTS
1316*	16-6717	$1.10(fs), $0.80(mf) OTS
1425*	16-6694	$1.60(fs), $0.80(mf) OTS
1465*	16-6718	Dep.(mc); $1.60(fs), $0.80(mf) OTS
1476*	16-7293	$2.60(fs), $1.04(mf) OTS
1482*	16-6719	$2.60(fs), $1.07(mf) OTS
1590*	16-7294	$8.10(fs), $2.75(mf) OTS
1619*	16-6720	$8.60(fs), $3.08(mf) OTS
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11213	16-7018	Dep.(mc)
11214	16-6922	Dep.(mc)
11215	16-7019	Dep.(mc)
11216	16-6540	Dep.(mc)
11217	16-6787	
11218	16-6804	
11219	16-6788	
11223	16-6506	
11224	16-6507	
11227	16-6697	
11228	16-6646	Dep.(mc)
11230	16-6254	Dep.(mc)
11231	16-6436	
11233	16-6722	
11236	16-6789	
11258	16-6267	
11261	16-6268	
11282	16-6269	
11283	16-6270	
NP-tr–	**(AEC File No. for Non-AEC Translations)**	
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NR–	**(Misc.)**	
132*	16-6789	See NP-11236
NRC–	**(Canadian)**	
6605	16-7040	Can. J. Phys. 40: 33-48(1962)
NYO–		
2530	16-6437	Dep.; $2.25(OTS)
9658	16-6903	Dep.; $2.25(OTS)
ONR–	**(Non-AEC)**	
9(Vol.I)	16-6541	
9(Vol.2)	16-6255	
ORNL–		

Report No.	Abstract No.	Availability
3213	16-6805	J. Appl. Phys., 33: 241-2(1962)
ORNL-TM-		
24	16-6723	Dep.(mc); $2.60(fs), $0.83(mf) OTS
OTS-	**(Misc.)**	
61-11429*	16-6687	$4.50(OTS)
PATENTS	**(German)**	
1064919	16-6678	For French translation see CEA-tr-A-837
PG-Report-	**(British)**	
236	16-6367	Dep.
PST-CAT.-	**(Misc.)**	
135*	16-6687	See OTS-61-11429
371	16-6388	See AEC-tr-4449
SB-	**(Non-AEC)**	
474	16-6683	$0.10(OTS)
482	16-6672	$0.10(OTS)
SR-	**(Misc.)**	
28*	16-6804	See NP-11218
STI-DOC-	**(International Atomic Energy Agency)**	
10/5	16-7305	$1.00(IAEA)
STI-PUB-	**(International Atomic Energy Agency)**	
34(Vol.I)	16-6465	$10.00(IAEA)
35	16-7145	$12.00(IAEA)
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3561(Rev.1)	16-6259	Dep.; $0.75(OTS)
7617	16-7295	Dep.; $1.75(OTS)
7619	16-6904	Dep.; $3.50(OTS)
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13957	16-7200	Dep.(mc); $5.60(fs), $1.79(mf) OTS
14209	16-6518	Dep.(mc); $3.50 as AD-264965
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6255	16-6519	Dep.; $0.75(OTS)
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